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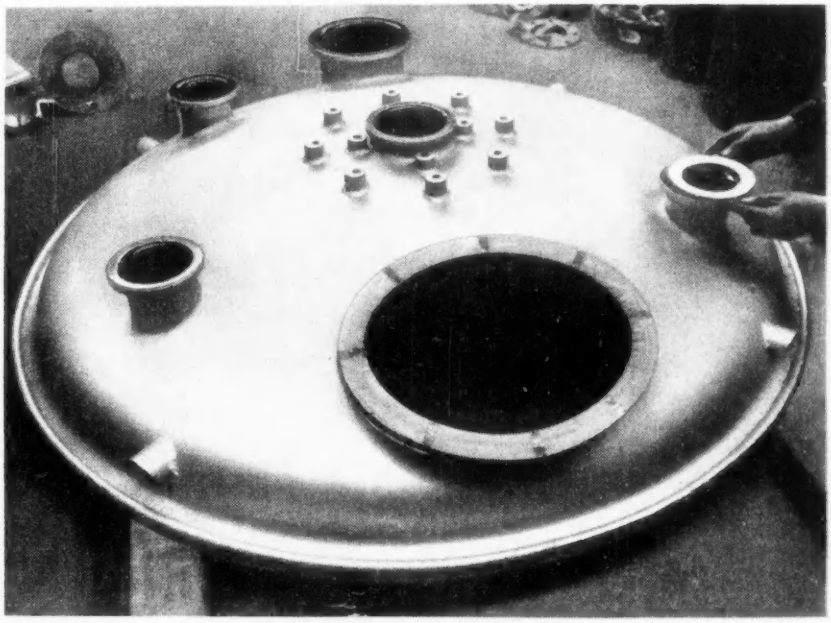

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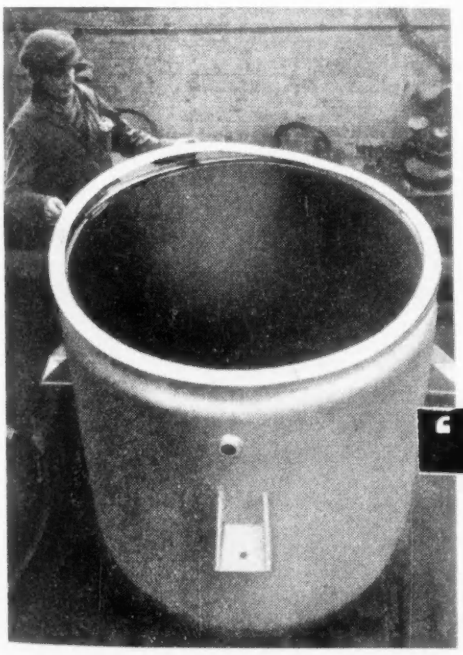

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Europe's Chemicals

WE have already given a summarised account of the OEEC report on 'The Chemical Industry in Europe' (see THE CHEMICAL AGE, 1955, **72**, 127). However, well-documented reports of this kind are not so frequently published that they should be dismissed with a single recognition. As in a number of other industrial and economic fields, the OEEC has produced a valuable reference handbook; judged from that standpoint, the report is an outstanding contribution, and is so in spite of the fact that commercial secrecy is still a strong influence in Europe, preventing the fullest publication of statistical data about chemical production. It is by comparison a simple enough task for a committee to survey some well-defined industry, e.g., fertilisers, chemical apparatus, rubber, etc. As mixed and complex an industry as the chemical industry in one country, let alone in 18 countries, presents a far more intractable problem. Indeed, it must be regarded as an impossible one; such a multitude of industrial activities can be usefully surveyed only from selected viewpoints and in terms of reasonably typical products. The OEEC Chemical Products Committee made it possible for the wood and the trees to be distinguished by severely limiting their objectives.

Although the overall OEEC picture shows that Western Europe is substantially a net exporter of chemicals, a number of countries are individually net importers—Austria, Denmark, Greece, Iceland, Ireland, Italy, Portugal, Sweden, and Turkey. In some cases the value of chemical imports greatly exceeds that of chemical exports. Italy's inclusion in this net importing group is perhaps surprising but it may be only temporary—her rate of increase in chemical production between 1951 and 1953 was easily the greatest among the OEEC countries, 57 per cent against Germany's 43 per cent in second place and against our own 20 per cent. In 1951 and 1952 Italy was slightly a net exporter of chemicals; not until 1953 did the balance in her external chemical trade tip in the adverse direction. This is no doubt wholly due to the lessened demand for Italian sulphur, exports of which have now fallen by almost 90 per cent in tonnage since 1951.

For Belgium, France, Germany, Holland, Norway, Switzerland and Britain, therefore, the pattern of chemical manufacture and trading is totally different. These seven countries are net exporters and it is their export balances which give the OEEC countries as an entirety an export-over-import surplus of some $800,000,000 (here, incidentally, the US dollar is used as a convenient common currency measure; the surplus is not in fact earned wholly in dollars). This suggests—and we need not politely evade the point—that there is no particularly valid reason why Europe's various national chemical industries should be collectively studied; or at any rate that the collective approach is motivated by politics rather than logic. Common interests, opportunities of gainful exchange of knowledge etc., are limited to individual and detailed similarities rather than to over-all likenesses. To say this is not to discredit the OEEC idea; it is simply to face facts insofar as chemical industries are concerned.

However, reliable surveys of facts and

figures are never futile, and even if OEEC's efforts show that the European pattern for chemicals is heterogeneous, they are well worth continuing as a form of information service. It seems clear that more detailed and more costly studies should however be devoted to special sections of the chemical industry which are reasonably developed in almost every country, such as fertilisers, sulphuric acid, etc.

Confining attention to the net exporting group of countries, the OEEC collection of figures enables some interesting comparisons to be made. In 1953 Britain's total exports of chemicals had a higher value than that of any other country—$496,694,000. Next came Western Germany's $477,220,000. Third place was held by France with $283,742,000. (All these figures, incidentally, relate to the group of chemicals defined in SITC Group 5.) But the true measure of an industry's contribution to the economy of a country which must export to survive is not solely the value of the total export trade secured. From the export value figure the value of chemical imports should first be deducted—it is the net gain that matters, not the gross export value.

This brings a sharp change into the picture. In 1953 our imports of chemicals reached a value of $211,765,000, which makes the net gain $284,929,000; but German imports totalled only $95,208,000, making the net gain for Germany one of $382,012,000—over 80 per cent greater than our own net gain figure. In this there is surely considerable food for thought. It is a point of comparison to which surprisingly little attention has so far been directed. However, it should not be assumed that German chemical production has brought about reductions in the need for imported chemicals more skilfully and more substantially. Much of the explanation must be found in the fact that the home market has been forced to accept a longer and stricter period of austerity. In fact, since 1951 German chemical imports have risen by about 23 per cent, whereas British imports have dropped in annual cost by over 30 per cent.

A useful measure of a chemical industry's contribution to national economy is obtained by expressing the net gain (annual export value less annual import cost) and the import cost as a ratio. For Belgium (including Luxembourg) this works out at 0.33; for France, 1.4; for Germany, 4.0; for Holland, 0.4; for Norway, 0.4; for Switzerland, 1.3; for Britain, 1.35.

For ourselves there is a most valuable pointer here. We are not expanding the value of chemical export trade at all strikingly—indeed, mainly through lower prices, the annual figure has been falling year by year since 1951—$540,000,000, $515,000,000, and $497,000,000 are the figures (rounded-off) for 1951, 1952, and 1953. We must assume from this that the law of limiting returns is beginning to operate, that each further expansion in value is requiring a greater input of effort and capital—our post-war progress has been excellent but we are nearer than other countries to our optimum share of world trade in chemicals. This may be unduly negative a viewpoint but it expresses a realism that only future events can falsify.

But there is still much progress to be made in raising the ratio of the net gain and our annual chemical import costs, which at 1.35 is a little lower than the ratio for France and so considerably lower than that of Germany. How much of the $211,765,000 expenditure upon imported chemicals can be saved by home production? We have already pointed out that this represents a 30 per cent reduction upon the similar (and Korea-inflated) figure for 1951, but there was a small increase, not a reduction, on the figure for 1952. Are we still paying sufficient attention to this aspect of chemical production? This would seem, at any rate on figures, to represent a more immediate opportunity for economic progress than difficult expansions of chemical export trade. Greater national independence may not perhaps reflect OEEC aims although it would seem to be their policy to encourage greater inter-country trade within Western Europe—if we judge by the plea made for more liberalisation of trade in chemicals.

Notes & Comments

Cheaper Spray Drying

SPRAY drying is an expensive process yet it must be used to meet specific conditions. Heat-sensitive substances, especially in the pharmaceutical and food industries, can often be kept from degradation during moisture removal only by use of the spray-drier. Also, when a very fine particle size or shape is required, spray-drying will sometimes be the only sure means of producing it. A spray-drying unit is large in size and therefore costly—the ratio of capital cost to output capacity is exceedingly high. The fuel cost is also high. Normally, the slurry that is introduced must be fairly wet in order to form the fine droplet spray which is injected into the vacuum chamber of the drier. A large volume of space as well as the slurry itself has to be kept at the requisite temperature. These cost-disadvantages naturally mean that spray-drying is resorted to only when other drying processes fail to give a satisfactory final product.

Proposed Means

A NEW means of reducing spray-drying costs has been tried out in the United States (*Chemical Engineering*, 1955, **62** [1], 118). The addition of a dispersant substance—in this case, tetrasodium pyrophosphate—enables a slurry with a much lower water-content to be fed to the drier. Where formerly the substance being dried had to be fed as a slurry with a solids-content of 25-30 per cent, it can now be fed as a free-flowing slurry with a solids content of 58-60 per cent. The drying-load has thus been approximately halved, and the rate of production of final dried product doubled. The amount of dispersant added is not large—it is used at the rate of 0.2 per cent of the weight of solids in the slurry. The application of this new method will be limited, of course, to materials in which the 0.2 per cent presence of a phosphate will not represent an impurity risk. It occurs to us, however, that similar spray-forming properties might be given to high solids-content slurries by using volatile organic dispersant substances; if so, much of the added dispersant would be removed by vaporisation in the spray-drying process itself, and the final dried and solid product would not be appreciably contaminated.

Problems . . .

DR. Rudolf Pribil's recent paper (see THE CHEMICAL AGE, 1955, **72**, 141) focused attention upon ethylenediaminetetra-acetic acid (or EDTA) as an analytical reagent, but it has enjoyed much larger-scale success in curing iron chlorosis in Florida's citrus plantations, where recurrent iron deficiency has long needed remedial treatment. The trouble with iron as an essential plant-food is that soil conditions often 'lock it up' so that adding iron salts to such soils still does not put iron into the plants or trees. Iron EDTA compounds overcame this difficult problem. It seems that the chelating radical can protect iron from chemical fixation by soil complexes, but when the chelated iron enters the plant it can nevertheless be liberated by enzymatic changes. Unfortunately, EDTA has proved successful only upon acid soils, and a great deal of iron chlorosis in crops is found in non-acid or alkaline soils. There are some very active research projects in hand, aimed at developing other chelating compounds which can 'handle' iron as a plant-food in non-acid soils.

. . . to be Ironed Out

A BRITISH communication in *Nature* (1955, **175**, 90) has revealed that HEEDDA (N.N'-dihydroxyethylethylene-diamine-diacetic acid), HEEDTA (N-hydroxyethylethylenediamine-triacetic acid) and DTPA (diethylenetriamine-penta-acetic acid) can be used to remedy lime-induced iron chlorosis. Actually the British work on pears and plums, centred from Long Ashton Research Station, used iron salts of HEEDTA and DTPA but not of HEEDDA. Foliage spray applications proved cheaper and more satisfactory than soil applications for plums and

peaches; though in one case iron EDTA and DTPA led to the first recorded cure of iron chlorosis in fruit trees in Britain from soil applications. It may perhaps be wondered why a chelated compound should be used as a foliage spray—if this method of application is used, why not simply spray a solution of iron sulphate or another simple iron salt? But even within the plant itself iron seems to be readily immobilised, held uselessly in non-available forms. The chelated iron is able to evade this fate, and the iron is then liberated at the sites of enzymatic activity and where it can fulfil its nutritional functions. A recent American paper (*Agricultural Chemicals*, 1954, **9** [11], 47) also reports development progress with HEEDTA and DTPA. There seems little doubt that the successful research promotion of iron chelates suitable for non-acid soils will bring wide opportunities for the organic chemicals involved. Iron chlorosis on acid soils is found to a limited extent; it is more widely encountered under neutral and alkaline soil conditions.

Forewarned

REMOTE control in the Montecatini nitroglycerine factory, described in our last issue (p. 221), has already saved lives. A few seconds before a mixture being kneaded exploded, a process control worker, watching the mixing on his television screen in an underground bunker 50 yards away, noticed that something untoward had occurred. He sounded the alarm, and 400 workers ran for shelter. All reached safety except 10, who were struck by flying glass. Without the new control methods there is no doubt that many more would have been injured, and some probably killed.

New Anhydrite Mine

SOME 90,000 tons of sulphuric acid a year, and a similar quantity of cement, will soon be added to present British production as a result of a mine opened on the West Cumberland coast last week. The mine, which contains anhydrite and runs under the sea bed, will be worked by Solway Chemicals Ltd., who are now completing a large plant for converting the anhydrite to sulphuric acid and cement.

Performing the opening ceremony was Sir Robert Chance, Lord Lieutenant of Cumberland. Others present included Lord Piercy, chairman of the Industrial & Commercial Finance Corporation, which has a substantial interest in Solway Chemicals Ltd. (controlling interest is held by parent company Marchon Products Ltd.). Lord Adams, who as general manager of West Cumberland Industrial Development Company has done much towards the exploitation of the anhydrite deposits, was also there.

Sir Robert Chance, Lord Lieutenant of Cumberland, pressing a button which put into operation conveyor belts bearing anhydrite from the mine. Others in the photograph are (left to right) Lord Adams, Mr. Frank Schon, Lord Lonsdale and Lord Piercy

Modern Packaging

Old & New Materials at Exhibition

THIS year's Packaging Exhibition, at the National and Empire Halls, Olympia, until 28 January, is the largest of the four staged so far in this country and probably the greatest exhibition of packaging that has taken place in the world. The exhibitions are held every two years under the auspices of The Institute of Packaging. At this year's, opened on Tuesday by the Lord Privy Seal (Capt. H. F. C. Crookshank, MP) and the High Commissioner for India (Mrs. Vijaya Lakshmi Pandit) there are more than 200 exhibitors from Britain and Europe.

Although the newer packaging materials, such as polythene, are well represented, there is still plenty of scope for the older types—glass, metal, stoneware, board and paper. Also on display are materials, such as waxes and glues, used in packaging; and machines for wrapping, exhibitors of which include a Swiss and an Italian firm.

Of particular interest are the polythene carboys, now being used in the chemical industry. These carboys, tougher and lighter than glass, come in a range of sizes from one to 60 litres, the prices varying from a few shillings to £13. A light wooden packing is available for an extra charge. These carboys are made by Fibrenyle Ltd., who also supply polythene bottles and jars for various uses.

Tubes . . .

Cascelloid Ltd., too, show polythene containers in capacities from ½ gal. to 10 gal. which are supplied with strong plywood outer cases and comply with railway authority and carriers' regulations. Also on show are Cascelloid's Tuboplast flexible polythene tubes which were described last week (p. 236) and in May last year (THE CHEMICAL AGE, 1954, **70**, 986).

A feature of the British Visqueen Ltd. stand is a demonstration of the water-resisting properties of their polythene film. This is shown by putting a typewriter wrapped in the film into a tank of water which, to give the illusion of the sea, has fish swimming about in it.

Demonstrations of high-frequency welding of PVC film are given on the stand of the Greenwich Leathercloth Co. Ltd., and flexible plastic containers used for the packaging of liquids, pastes, etc., are displayed by Plastic Weldings Ltd. BX Plastics Ltd. include in their stand Cobex, one of the latest additions to their range of sheet thermoplastics, which is essentially a rigid unplasticised polyvinyl chloride based material.

. . . And Caps

A machine putting caps on tubes is on show at Evans Chemicals Ltd. (Production and Packing Service) stand. Evans Chemicals not only pack the branded products of other manufacturers but also, where desired, do the manufacturing at their own plant. The work is done under conditions of strict confidence and they do not produce or pack anything on their own account.

Waxes used in packaging are shown by the Whitehead Chemical Co. (Waxes) Ltd. In recent years extensive research on specialised waxes for the packaging industry has resulted in a large increase in their use and application. They are primarily used for protection against moisture vapour, chemicals and climatic conditions, but also enhance sales appeal.

The display of British Glues and Chemicals Ltd. shows the versatility of animal glues in the packaging industry.

Machines that place the cap on a bottle and then screw it home, with from 1,000 to 8,000 an hour are demonstrated by Fords (Finsbury) Ltd. Many of these have been supplied to chemical and pharmaceutical firms.

On show at Manesty Machines Ltd. stand is their DryCota tablet making and compression coating machine described last September (THE CHEMICAL AGE, 1954, **71**, 642). There are also other Manesty products, such as the rotary tablet machine. Baker Perkins Ltd. display a comprehensive selection of automatic wrapping and carton-forming machinery in association with the Forgrove Machinery Co. Ltd. and The Package Machinery Co., USA.

All aspects of packaging are dealt with by exhibitors of whom only a brief selection has been given this week.

Part of the fleet of Ford vans which have just gone into action for the balance maintenance service of L. Oertling Ltd. The company provide service throughout the country by resident mechanics, and the new vans are intended to speed up their movements and give even better service than in the past

I.C.I. Terylene

Plant Output Rising Rapidly

ON 19 January, Imperial Chemical Industries Ltd. welcomed representatives of the Press on their first visit to the new Terylene plant at Wilton. Dr. A. Caress, chairman of the Terylene Council, speaking at the beginning of a tour of the plant, said:—

'Many of you will recall, as I do, the Press Conference in London in October 1952, when we announced that the construction of a large plant here at Wilton to make 11,000,000 lb. of Terylene per year had been started. We were aiming then to have the plant starting to operate by about the turn of the year 1954/5, and I am glad to say that our hopes have been realised. You will be able to see the new plant in operation, but we estimate that it will be some months yet before every unit of this complicated chain of new processes is at full output. During the course of your tour you will observe that most of the buildings are being extended. These extensions are to house the additional equipment required to double the output of the first plant. This expansion was announced last year and should come into effect in about a year's time.'

Dr. Caress also announced that it was intended to hold a large exhibition in London at the end of March, by which time the plant should be sending out considerable quantities of fibre. Soon after it is expected that a continually increasing flow of fabrics, garments and industrial products will become available.

A fully illustrated feature describing the new Terylene plant will appear in THE CHEMICAL AGE *for 29 January.*

Showrooms Opened

THE new offices, showrooms and warehouse of the Baird & Tatlock group of companies at 58 Lever Street, Manchester 1 (Tel.: Central 0937/8) opened on 10 January.

On Friday, 7 January, a press conference was held at the new showrooms attended by about 30 reporters from newspapers and scientific and trade journals. Mr. J. E. C. Bailey, C.B.E., the chairman and managing director, welcomed reporters and gave a short talk on the developments of scientific instruments and chemicals and the increasing demand for them from the North of England. He stressed the dependence of scientific development on the scientific instrument industry and the link between the new discoveries in science and the progress of scientific instruments.

Mr. Bailey hoped that the new showrooms would provide scientists in the North of England with facilities previously only available in London and trusted that they would avail themselves of the new showrooms to inspect new and improved instruments and chemicals.

Liquid Entrainment

Part I. Mechanism of Drop Formation from Bubbles*

A BUBBLE of moderate size (say 0.5 cm. dia.) rising through a liquid usually assumes an ellipsoidal form, and rocks in a vertical plane about the longer axis. The terminal velocity of ascent is, over a wide range of sizes, nearly independent of size. When the bubble reaches the surface of the liquid it usually rebounds back and forth with decreasing amplitude until, just before collapse, it comes to rest with its upper part projecting above the surface in the form of a hemispherical dome. The walls of the dome are extremely thin at the apex but thicken towards the base.

The time-lag between the bubble reaching the surface and collapsing will depend on the state of the interface. If dirt, salts, or other stabilising agents are present the bubble may remain on the surface for an appreciable time; even in reasonably pure water the time-lag before collapse is of the order of 1/100 sec.

While the bubble is intact the pressure inside it will be greater than the surrounding pressure by an amount Δp depending upon the curvature of the liquid envelope and its surface tension γ:

$$\Delta p = 2\gamma\left(\frac{1}{R_1}+\frac{1}{R_2}\right)$$

where R_1 and R_2 are the principal radii of curvature. Since the upper dome is nearly hemispherical in shape, $R_1 = R_2$ and

$$\Delta p = (4\gamma)/R_1$$

The water level at the base of the bubble is depressed below the surrounding surface by an amount r given by

$$r = 2\gamma/(gp\omega h + c)$$

where h is the hydrostatic head of the surrounding liquid, g is the gravitational acceleration and c is a constant. For small bubbles $r = R_1/2$.

The collapse of the bubble is associated with a release of energy sufficient to impart a comparatively high velocity to any drops formed and to give rise to a wave disturbance in the surrounding liquid. It is important to know by what mechanism the bubble breaks up and the origin of the drops formed.

The work of Dombrowski and Fraser in these laboratories affords strong evidence that a thin liquid film breaks up by the initial formation of a number of perforations which subsequently expand to give a lace-like structure. The liquid ligaments so formed are unstable and break into small drops of varying size. Fig. 1 shows such a film in the process of disintegration.

To resolve these conflicting views, the authors have judged it advisable to try to obtain further data on the mechanism of collapse and for this purpose have employed various photographic techniques. The main experimental difficulty is due to the occurrence of three time intervals of widely differ-

* From a paper by Dr. N. Dombrowski, Dr. F. Knelmann & Prof. D. M. Newitt, read at a meeting of the Institution of Chemical Engineers in London on 18 January.

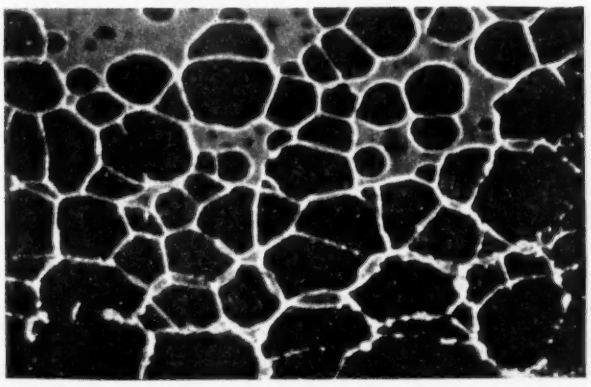


Fig. 1. A thin liquid film in process of disintegration

ing magnitudes. The first of these, the lifetime of the bubble at the interface, may be of the order of 1/100 sec. or longer; the actual bubble burst will occupy a few microseconds, whilst events subsequent to the burst extend over a few milliseconds.

The problem regarding the last two intervals is essentially that of synchronising a flash exposure with the event. Using an Arditron flash, which has a duration of about 2 microseconds, various methods of synchronisation were used based upon the action of a beam of light reflected from the dome of the bubble on to the activated cathode of a photo-cell. One method depended upon triggering the flash by means of the contact made by a needle probe with the wave formed on the interface immediately after the burst. By positioning the probe radially from the bubble axis at various distances, photographs of successive stages of the post-burst events could be taken.

Sequence of Events

The sequence of events as revealed by these techniques is shown diagrammatically in Fig. 2. The mechanism of collapse appears to be as follows (see Fig. 2):—

The bubble coming to rest at the liquid surface forms the hemispherical dome, Fig. 2 (*b*), its internal pressure producing a depression of the interface. Liquid drains from the dome until the upper part is so weakened that the internal pressure causes the formation of a secondary cap, (*c*). This cap subsequently disintegrates (*d*) by the mechanism illustrated in Fig. 1, giving rise to droplets of a few microns in diameter. These droplets, which are too small to be seen in the photographs, are carried away by the rush of gas issuing from the perforated dome.

The result of these events is to set up a system of standing waves, shown clearly in the figures, and to leave a well defined crater, (*e*), in the interface. As the crater fills in, the momentum of the inflowing liquid produces a jet, (*f*), which rises at high velocity and in certain circumstances detaches one or more comparatively large drops, (*g*), (*h*), from its apex. It is these drops, which may have a diameter of the order of 0.1 cm., that are responsible for the main losses by entrainment. The jet then retracts and the surface of the liquid returns to rest.

It will be apparent from the above observations that a quantitative study of entrainment must take into account two systems of drops, the one derived from a disintegrating dome of liquid and consisting of clouds of drops of a few microns in diameter, and the other of comparatively few large drops derived from the breaking up of rising jets of liquid. There will be a size distribution in each system and hence in determining the effect of certain variables upon the behaviour of the system as a whole it may be necessary to define a mean size of drop. For this purpose we shall use the 'Sauter Mean Diameter.'

$$D_{L,S} = \frac{\Sigma \triangle nD^3}{\Sigma \triangle nD^2}$$

where D = average of size range, the subscripts $_L$ and $_S$ relating to large and small drops respectively and $\triangle n$ is the number of drops counted in a size range whose mean is D.

The factors which might be expected to influence the size and ballistics of the drops are:—

(i) the physical properties of the liquid,
(ii) the depth of submergence of the orifice producing the gas bubbles,
(iii) the diameter of the gas bubble,
(iv) the rate of bubble formation, and
(v) the temperature of the liquid.

Experimental Results

The system used in the experiments to be described is, unless otherwise stated, air-water. The bubbles were generated from a glass capillary orifice orientated in a horizontal plane at various depths below a water-air interface, the size of bubble being controlled by the diameter of the orifice.

Drop sizes were determined by allowing the drops to impinge on plates coated with magnesium oxide and situated at predetermined heights, h, above the interface. The impact of the drops formed craters, the diameters of which were measured by means of a travelling microscope and related to the diameters of the corresponding drops by a suitable calibration technique.

The lower limit of diameter measurable with reasonable accuracy by this method is about 20 microns.

A series of experiments was carried out with five bubble sizes ranging from 0.31 to 0.53 cm. diameter at temperatures of 25°, 35°, and 45°C. For each bubble size observations of drop size and number were made at heights, h, of 0.64, 1.91, 3.17, 4.44 and 5.71 cm. above the interface.

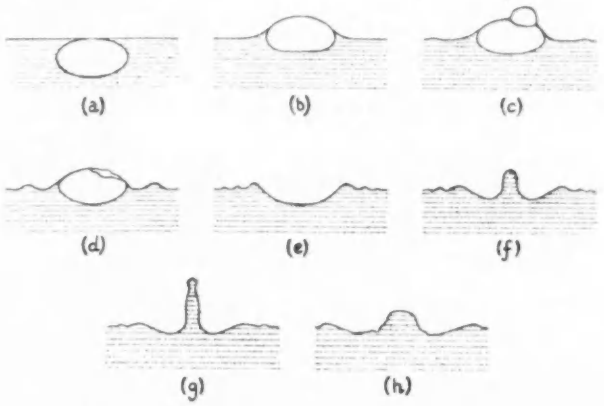


Fig. 2. Stages in the collapse of a bubble

From the results it is seen that in all cases D_L decreases nearly linearly and N_L (the number of drops produced per minute) increases with decreasing bubble diameter. Furthermore both D_L and N_L decrease with rising temperature, and the change in the number of drops produced by large bubbles decreases markedly as the temperature is raised.

The reason for this will become apparent when the properties of the rising jet producing the drops are considered. The velocity of the jet and the height to which it rises are functions of the size of crater in which it originates (and hence of the size of the gas bubble) and of the surface tension of the liquid.

At the lower temperatures, a relatively longer jet is formed than at higher temperatures. This results from the initial resistance to break-up at the higher viscosity. Thus, there is a longer time for a drop to detach before the jet is drawn back to the surface. This tendency for drop formation is further aided by the higher surface tension.

In general, over the bubble range employed, less than one drop is produced per bubble. As the bubble diameter is reduced, its internal pressure rises and the energy available for jet formation therefore increases. That gives rise to jets of higher initial velocity and hence greater unbroken length. Here it may be recalled that Stuhlman, experimenting with bubbles of 0.25 cm. diameter or less, showed that the resulting jets become progressively thinner with decreasing bubble diameter and break down into two or more drops per jet.

The pattern produced on the impact plate and the variations of D_L and N_L with the height of the plate above the interface give a measure of the initial velocity and direction of flight of the drop. The larger the bubble diameter the greater is the decrease of D_L with height. For any one bubble size there is a distribution of main drop sizes and normally the majority of drops rise to some characteristic height. As the height of the impact plate is raised from 0.64 cm. to 5.71 cm. there is a gradual redistribution of particle sizes, the larger ones being progressively eliminated as the height is increased. The greater the bubble diameter the lower is the characteristic height, and hence the decrease of drop size with height is greater for the larger bubble sizes.

The height to which the drops rise is, as would be expected, reduced by increase of temperature of the liquid.

The system of small drops is subject to conditions which render the results somewhat difficult to interpret. In the first place, the drops are subject to violent disturbance by the rush of gas escaping through the collapsing bubble. Thus, instead of travelling almost vertically upwards as do the large drops, the crater distribution on the impact plate at a height of 0.64 cm. lies within a circle of diameter as much as 10 cm. indicating that drops travel outward from the point of burst at angles of up to 80° from the vertical. For this reason, at greater heights the majority of particles miss the impact plate. Furthermore some of the smaller drops may disappear completely and others decrease in size by evaporation as they travel outwards at high velocity.

Visual counts indicate that the number of large drops formed per minute is approximately constant at all depths of orifice sub-

mergence greater than 2.54 cm. As the depth is reduced below 2.54 cm. there is a sharp decrease in the number of drops to a minimum of 0.64 cm. after which the number again increases. At depths less than 0.32 cm. a continuous channel forms, and at the surface the bubbles tend to grow large and to burst without the formation of large drops.

Function of Baffles

In many types of entrainment separators a system of baffles is employed to deflect the gas stream so that entrained drops are carried by their momentum on to the baffle whilst the gas passes round it. The drops striking the face of the baffle form a liquid film which drains to the lower edge of the baffle. The film then reforms large drops which fall out of the gas stream and may be collected.

Several possible sources of re-entrainment present themselves in the above situation. Firstly, the drop may be atomised by impact on the baffle face and the resultant smaller drops re-entrained. Secondly, drops may be atomised by the gas stream during their period of formation and detachment at the baffle edge. Lastly, the drops may be re-entrained as they fall from the baffle edge. At sufficiently high gas velocities large drops may become unstable and atomise.

In effect, a baffle acts as an agglomerator —producing large drops from smaller ones which have impinged on its face. A knowledge of the size of drops detaching from baffle edges is of interest since several investigations have established the critical size for instability of drops in gas streams. It is also important to know the size of detached drop as a function of the thickness and shape of baffle edge and of the velocity of the gas stream.

In order to obtain data on the behaviour of baffles a wind tunnel was constructed. It consisted of a rectangular perspex duct fitted with a constant-head liquid feed device and adjustable baffles. A calibrated Venturi throat was attached to the duct enabling air velocities to be measured.

The baffles were constructed of brass plate 0.08, 0.16, 0.32, 0.96, 1.27 and 1.92 cm. respectively, each baffle having one square edge, one 90° V-shaped edge and one 45° bevelled edge.

The arrangements were such that drops of predetermined size could be injected into the gas stream and, when fully accelerated, allowed to impinge on the baffle; or liquid could be supplied at a constant rate to one face of the baffle and allowed to drop off its lower edge.

Individual drops of various sizes were projected into the air stream and allowed to impinge on the baffle face. The air velocities were raised from 610 to 2,130 cm. per sec. and a high-speed cine-camera was used to record the results. In addition a large number of visual observations were made of drop impact. In no instance was there any evidence of rebound or break-up; the drop on impact deformed to a flat disc which subsequently spread to a thin film.

In all cases the drop diameters at first decreased with baffle thickness, passed through a minimum corresponding with a thickness of about 0.22 cm. and then increased. For the square-edged baffle the increase in diameter was fairly considerable up to a thickness of about 1.2 cm. after which it tended to a constant value of about 0.8 cm. For the V- and bevelled-edged baffles there was only a slight increase in diameter with thickness from the minimum of 0.4 cm. to a fairly constant value of 0.47 cm. at thicknesses of 1.0 cm. and upwards.

When the number of drops formed per minute was increased from 10 to 180 there was a small decrease in average drop diameter amounting to not more than 5 per cent.

Re-Entrainment

The phenomena associated with re-entrainment were observed photographically using a Kodatron flash unit or alternatively the high-speed cine-camera. The drops were detached from a conical baffle in an air stream at average velocities of 792, 1,190, 1,580, 1,980 and 2,340 cm. per sec., respectively.

The table opposite summarises the measurements made from the films and includes drop sizes of the large drops and satellites, velocities, and other details.

The deflections S_h and S_v are the horizontal and vertical distance from the point of initial detachment to the final appearance of the drop in the sequence. U_h and U_v are the average velocities over this range. Above 1,190 cm. per sec. the drop has practically no vertical component of velocity over the distance measured.

The horizontal deflection is a quantity important in the design of separating and classi-

fying equipment for positioning take-off and exhaust ducts.

Examination of the high speed cine-film indicates that below velocities of about 1,200 cm. per sec. the air stream does not materially affect the mode of detachment of the drop. At greater speeds the air stream tends to tear the drop from the drip point producing an elongated jet which detaches, and may or may not produce a satellite. The process is similar to atomisation by spinning discs.

At velocities above 1,800 cm. per sec., atomisation increases and several satellites are formed. At the highest velocity, 2,340 cm. per sec., atomisation is continuous, drops being torn off from the main drop as fast as liquid pours into the drip point. Moreover at this velocity drops tend to be unstable and may be stretched to a thin film or bag with a thick rim. The rupture of this film will then produce the same systems of small and large drops as do bursting gas bubbles.

Conclusions

It has been shown that the generation of drops by bursting bubbles is influenced by the depth of bubble generation, by bubble diameter, and by the physical properties of the liquid. It is thus possible to control to some extent the incidence of entrainment. Thus, for example, an increase in bubble diameter will reduce the number of larger drops (N_L) while increasing the number of small drops (N_S); it will also increase the size of the large and reduce that of the small drops.

(1) By a proper control of bubble diameter it is possible to operate under optimum conditions. This may be illustrated by comparing the two bubble diameters 0.53 and 0.311 cm. in an air-water system. If 1 cc. of vapour is considered, there will be 13 bubbles of the larger diameter producing a total of 2.33 large drops having a mean diameter of 0.1 cm. and 156 small drops having a mean diameter of 22 microns. The same volume will produce 64 of the smaller bubbles, generating a total of 63 large drops of mean diameter 0.074 cm. and 100 small drops of mean diameter 58 microns.

In general, the elimination of large drops is fairly simple. In evaporation it may be accomplished by increasing the vapour space and in plate columns by increasing the plate spacing. Thus at a superficial vapour velocity of 30 cm. per sec. a plate spacing of 15.2 cm. will eliminate a 0.1 cm. diameter (U_o = 100 cm./sec.) drop; a 0.05 cm. drop will require a plate spacing of approximately 25 cm. (U_o = 240 cm./sec.).

(2) When bubbles are generated at very shallow depths there is a marked decrease in the number of large drops. Several authors have noted the effect of depth of liquid seal on entrainment in plate columns and Eduljee[3] has proposed an optimum depth to minimise entrainment. This author's experiments have shown that at a depth of 0.64 cm. there is a very considerable decrease in N_L. With depths lower than 0.32 cm., continuous channelling occurred, resulting in large bubbles which burst without the formation of large drops. Spells and Bakowski have shown that in these circumstances—but at very much higher air rates than those used in these experiments—a considerable number of drops are torn from the top of the channel.

(3) Furthermore the depth at which a bubble is generated affects the trajectory of the main drop it forms on bursting. By choosing depths at which the velocity of the resultant drop has a strong horizontal component, vapour spacing could be reduced and baffles arranged near the interface could be employed with advantage. It has also been

THE CHARACTERISTICS OF RE-ENTRAINED DROPS

air velocity (cm./sec.)	Sequence	Drop diameters: Large (cm.)	Drop diameters: Satellite (cm.)	Deflections: *Sh* (cm.)	Deflections: *So* (cm.)	Average velocities: *Uh* (cm./sec.)	Average velocities: *Uo* (cm./sec.)
792	—	0.354	None	1.86	1.92	36.8	30.7
1,190	—	0.345	None	2.14	1.82	43.6	33.5
1,580	(*a*)	0.350	None	7.8	0.67	178	14.9
	(*b*)	0.314	0.100	7.7	1.08	140	18.9
1,980	(*a*)	0.363				180	
			0.171			130	
			0.143			127	
	(*b*)	0.245				177	
			0.133			142	
			0.067			164	
			0.067			164	
2,340	(*a*)	0.100	continuous			257	
	(*b*)	0.100				313	
		0.100	atomisation			533	
		0.210				216	

shown that small drops have a flat trajectory on a high initial velocity and here again some form of splash deflector should be advantageous.

It has been noted that temperature has a significant effect in reducing the number of large and small drops in an air-water system, and advantage might well be taken of this circumstance in the production of distilled and heavy water. Since the effect of reduced surface tension is to decrease both N_L and N_S, the addition of small amounts of surface active agents in evaporation and distillation process might in some cases be used to control entrainment.

(4) It has been noted that the behaviour of drops detaching from baffle edge can be analysed on the basis of the relation found by Lane giving the conditions at which instability occurs (i.e., at $U^2D = 61.2 \times 10^4$). Thus for a water drop 0.35 cm. in diameter, the relative velocity, U, should be less than about 1,000 cm. per sec. Above this velocity atomisation occurs with significant re-entrainment.

It has also been confirmed that there is a minimum baffle thickness at which the detaching drop attains a maximum diameter. This thickness is about 1.9 cm and water drops detaching from such a baffle are about 0.78 cm. in diameter. Moreover drops from a bevelled edge are smaller than those from a square edge and therefore, if excessive pressure drop is not involved, baffles should have square leading edges.

A consideration of the physical dimensions of the system and the ballistics of the drops should enable the optimum number, size and arrangement of the baffles to be determined.

Expanded Metal Column Packing

*Performance of Spraypak**

UNTIL comparatively recently, all large-scale distillation operations were carried out in bubble-plate, or to a lesser extent, perforated plate towers. These contact devices are identical in principle with those in use in the alcohol industry more than 100 years ago, although their detailed design has been much improved. For smaller scale operations, towers packed with random fillings such as Raschig rings or Berl saddles are often used, although these suffer from a lack of flexibility due to their rapid change in performance with throughput. In addition, such towers are not normally economic for distillation purposes in diameters above about 3 ft., due to channelling, although they are more effective in absorption operations where the liquid rates are relatively greater and larger packing elements can be used.

Within the past few years, considerable advances have been made in distillation techniques, and a number of new designs, both of bubble- and perforated-plate trays, and of trays and packings of completely new design, have been introduced. Among these, particular mention must be made of the Shell Turbogrid plate[1], the Kittel expanded metal tray[2], the Scofield multi-layer expanded metal packing later termed Panapak[3], and finally Spraypak single-layer expanded metal packing[4].

The Turbogrid and Kittel trays are similar in that both consist of flat perforated plates without downcomers; the former comprises flat bar grids or slotted plates with 15-25 per cent free area, and the transfer of liquid from plate to plate takes place by a random intermittent 'logging' of the slots. The Kittel plate on the other hand uses plates constructed from expanded metal of similar free area. These are installed in pairs in such a manner that the upper plate directs the liquid tangentially outwards towards the wall, giving it an apparent swirling motion, while the lower plate directs it inwards towards a central core. The liquid accumulates to a sufficient depth at the wall or the centre to stop bubbling and to enable it to pass downwards through the mesh.

The Scofield Panapak packing is somewhat different in principle from the foregoing since it operates mainly by spraying rather than bubble formation. It comprises a series of corrugated capillary mattresses, each made from about seven sheets of wide mesh

* Summary of a paper by J. A. McWilliams, H. R. C. Pratt, F. R. Dell and D. A. Jones, also read on 18 January.

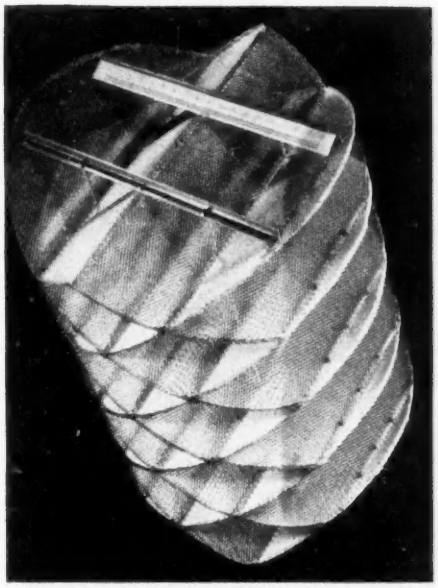
expanded metal lath. The main advantage of this packing is the very large throughput, about 150 per cent above that of a bubble plate column with 1 ft. 6 in. tray spacing.

The present work was carried out in order to satisfy the need for a low-cost high-efficiency packing with a very large throughput, suitable for the large-scale separation of the hydrogen isotopes by the distillation of water. This was required in order to take advantage of the availability of very cheap steam from geothermal sources in New Zealand, since preliminary calculations had shown that the capital charges would make the process uneconomic with conventional distillation columns even if the steam were available at zero cost. The large capacity required can be gauged from the fact that, at atmospheric pressure, it is necessary to evaporate approximately 330,000 tons of water to produce one ton of heavy water. The large throughput of Panapak suggested that this packing might have possibilities for the present purpose, and a research programme was therefore instituted in order to investigate its performance particularly with the H_2O-HDO system. This led to the development of the single-layer type of expanded metal packing now known under the name Spraypak.

For most applications the packing is made from commercial $\frac{1}{2}$ in. nominal mesh 20-24 SWG expanded metal of 1/16 in. strand width to form a continuous cellular structure. The walls of each cell are separate but identical Z-shaped pieces bolted, welded or clipped together and supported by vertical rods and distance pieces. In an alternative form of construction the short sides are bent in such a way that, when clipped together, the cell intersections are vertical instead of longitudinal. Modified forms of construction have also been devised which are suitable for installation through the manholes of conventional tower shells.

For convenience, most of the work to date has been carried out using aluminium mesh, but it is envisaged that in most instances stainless steel would be used in commercial plant.

In air-water tests at low liquid rates and gas rates approaching zero the liquid runs as a more or less continuous film over the cell walls, while at higher liquid rates some of the liquid tends to stream through the packing mesh from cell to cell. As the gas rate is increased the streaming ceases and the liquid film is disrupted with the formation of bubbles. Above about 20 per cent of the flooding rate the film begins to be detached from the upper portion of the cell walls and spraying sets in. The trajectories of the spray droplets become inclined more and more as the gas rate is further increased, and at angles somewhat above the horizontal a limited amount of entrainment from lower to higher courses occurs.



An example of Spraypak. The ruler is 15 inches long

In distillation tests at total reflux, where the mass flows of liquid and vapour are the same, the liquid flows on the strands of the mesh, around the mesh holes, at the lowest boil-up rates. At 20-25 per cent of the flood point the strands overload and partial filming and bubbling starts. At slightly higher rates spray formation sets in, and is virtually complete over all the surfaces at about 35 per cent of the flooding point.

The density of the spray and the contacting efficiency increase steadily up to the flood-point. It is characteristic of Spraypak that operation is stable at, and somewhat above, the graphical flood point.

Typical distillation data for four packs using both the systems investigated, H_2O-HDO and benzene-CCl_4, are plotted in the form of HETP and pressure drop per theoretical plate against per cent of flooding. It

is gratifying that the HETP data for the two systems do not differ greatly, particularly in view of the large differences in physical properties of these systems.

It appears probable that the limiting values of the HETP at the flood point are substantially independent of pitch, and inversely proportional to course height, corresponding to a constant course efficiency in the latter case. The shape of the HETP curve depends to some extent upon the packing geometry, however, probably as a result of variations in liquid distribution. Thus the liquid film appears to increase in thickness as the pitch is increased, resulting in flatter HETP curves. Reducing the course height at the same time has the effect of reducing the HETP although at the expense of a somewhat reduced throughput.

REFERENCES

[1] Shell Development Co., *Chem. Eng. Prog.*, 1954, **50**, 57.
[2] Anon., *Chem. Eng.*, 1953, **60**, [4], 242.
[3] Scofield, R. C., *Chem. Eng. Prog.*, 1950, **46**, 405.
[4] Anon., THE CHEMICAL AGE., 1954, **70**, 1301.

Mobile Demonstration

New Unit for IDL

FIRST public appearance took place on 14 January of the new mobile unit of Isotope Developments Ltd. Housed in a 2-ton Fordson van are a selection of instruments manufactured by the company, all set up for immediate demonstration. The sale of specialised instruments in the field of isotopes and nucleonics must be made by direct contact with the technicians, and it is for this reason that the company has put the unit on the road. It is intended to further sales both in Great Britain and on the Continent.

The unit provides its own stable source of power, supplied by a take-off from the gearbox. A range of laboratory instruments is carried, including a simple and inexpensive monitor intended for educational purposes in schools. Industrial exhibits are a beta-gauge suitable for continuous measurement of thickness, as in paper or textile mills; a package monitor for checking correct filling of containers on high-speed conveyor belts; and an ionisation anemometer which, without the use of moving parts, will measure very low-speed air currents in the range 10-300 ft. per min.

Welcoming visitors to the demonstration, Mr. R. D. Peters, chairman of the company, said that the presence of Lord Waverley was particularly gratifying: he had played an outstanding part in the history of atomic energy, not only as the Minister responsible for atomic work during the war, but more recently as chairman of the Government committee responsible for the formation of the UKAEA. Other guests included Sir Donald Perrott, secretary of UKAEA; Sir George Erskine and Mr. W. W. Hill-Wood, managing directors of Morgan Grenfell & Co.; and Dr. H. Seligman and Dr. D. Taylor, from Harwell.

A view of the interior of the van, showing the range of equipment carried

Synthetic Ester Lubricants

Suitable Greases for Low & High Temperatures

AMONG the problems which arose during the war was the lubrication of instruments, particularly those for aircraft use. The requirements for such lubricants included stability, low viscosity, low volatility, low freezing point, and a small temperature coefficient of viscosity. Conventionally-refined petroleum oils were unsatisfactory for instrument lubrication, since high V.I. fractions do not have sufficiently low freezing points and are characterised by excessive volatility and low flash points.

In 1942, the US Naval Research Laboratory in Washington undertook a basic investigation of the problems involved in low-temperature instrument lubrication. The results obtained using aliphatic diesters as lubricants were fully reported shortly before the end of the war. It was found that a number of aliphatic branched-chain diesters possessed the requisite properties, not only for the lubrication of instruments, but also for many other military applications in aircraft and ordnance equipment. During the corresponding period, a German group under the leadership of H. Zorn[1] investigated independently the use of esters as special-purpose lubricants and concluded that several branched-chain aliphatic esters were outstanding for this application. This work was later reviewed by Tingle[2] in Britain and by Horne[3] in the United States.

Post-War Problems

Since the war a variety of special lubrication problems have arisen. Aircraft gas turbines, for example, require oils capable of providing adequate lubrication at temperatures from −65° to about 275° F, with temperatures on shut-down as high as 500° F for intervals of one or two hours. Automotive equipment under Arctic conditions is required to operate at what were formerly considered prohibitively low temperatures for conventional oils and greases. At the low temperatures prevailing not only in the Arctic but also at high altitudes, machine guns and automatic cannon frequently could not be made to fire due to congealed lubricants.

Because of their versatility and other advantages there has been an increasing demand for synthetic ester lubricants, which are finding a growing field of application. Since 1945 the Naval Research Laboratory has therefore endeavoured, through its own research and through encouragement of industry, to extend the supplies of such lubricants by allocating additional sources of native raw materials for their production and by developing new classes of esters. The results obtained on numerous esters investigated at this laboratory since 1945 are presented in a report which has been made available to the Technical Information and Documents Unit of DSIR.[4]

Earlier Research

Syntheses of suitable esters at the laboratory, and in many instances at co-operating industrial laboratories, were guided by the results of previous research on the relation of molecular structure of liquids to lubricant properties. This guidance substantially reduced the number of compounds requiring synthesis and extensive study. Earlier work indicated that the following generalisations, which applied to hydrocarbons, were also valid in connection with esters:

1. Increasing the chain length increases the viscosity, raises the freezing point, and improves the viscosity-temperature characteristics as evidenced by higher viscosity indices.

2. The addition of side chains increases the viscosity, lowers the freezing point, and has an adverse effect on the viscosity index and ASTM slope.

3. The position of the branched chain exerts a variable influence on the viscosity and viscosity index. Branches near the middle of the chain are more effective in lowering the freezing point.

4. The addition of cyclic groups causes larger increases in viscosity and has a more adverse effect on the viscosity index and ASTM slope than the addition of alkyl groups.

5. Increasing the ratio of the cross section of the molecule to its length adversely affects the viscosity index and ASTM slope.

These generalisations suggested that the high viscosity indices of long chain molecules result from their ability to coil and

uncoil reversibly with variations in temperature. Such coiling is made possible by freedom of rotation about the chemical bonds in the principal chain. Since branching increases the ratio of cross section to the length of the molecule and also restricts the rotational freedom, smaller viscosity indices result. In this connection it should be noted that unbranched diesters have slightly lower viscosity indices than analogous hydrocarbons because the carbonyl oxygen behaves as a branched chain. It has been shown that these generalisations also hold good for ethers, thioethers, amides, silicones and halocarbons.

Higher Temperatures

In the early work on synthetic diesters for instrument oils, it was not anticipated that prolonged exposure to temperatures above 100 to 125° C was likely to be encountered. Since the war, however, service requirements and the effects of new designs and new materials have been such that lubrication at increasingly high operating temperature is required. Thus the trend in instrumentation is toward sealed, more compact, and hotter operating units. Furthermore, the use of silicone resins and other new high-temperature insulating materials has increased the upper operating temperature limit for electric motors to around 150° C.

In view of this trend, a study was initiated in 1946 to relate the structural configuration of the pure liquids of interest as synthetic lubricants to oxidation stability. Employing a cyclic oxygen absorption apparatus, Murphy and Ravner[5] demonstrated that the oxidation of diesters over the range of 100 to 150° C is an autocatalytic chain reaction, the rate determining step being the decomposition of the peroxides formed during the early stages of oxidation. As measured by activation energies and reaction rates, the stabilities of these synthetic liquids are of the same magnitude as those of white mineral oils and hydrocarbons. Structural variations among the diesters account for variations in activity. It was found, as with hydrocarbons, that the carbon atoms most subject to oxidative attack in diesters are H_3C-, $H_2C=$, $HC\equiv$ in order of increasing reactivity. However, the completely substituted carbon atom is quite resistant to oxidation. The reactivity of oxidation-labile bonds was found to decrease as the bond approaches more closely to a carbonyl oxygen or an alkyl branch. This effect is evidently steric.

It has been demonstrated previously[6] that diesters could be adequately protected against oxidation at 100° C with conventional antioxidants. Until recently, however, little attention has been paid to inhibitors for more elevated temperatures. Many widely used inhibitors were developed as additives for internal combustion engine oils, but it does not necessarily follow that they would all be satisfactory for new applications; e.g., in turbo-jet engines, where oxidation conditions are more drastic. Moreover, antioxidants considered unsuitable for automotive use due to cost, generation of valve deposits, or colour changes, need not be rejected and may be valuable in oils for gas turbine systems.

An investigation of various classes of inhibitors was undertaken at the Naval Research Laboratory, and the preliminary results obtained at temperatures up to 163° C were incorporated in an interim report in 1949[7]. Since the effectiveness of antioxidants has been shown to vary with the presence of impurities in the additives and in the reference liquid, only compounds of high purity were used in this comparative study. Nearly all the additives were either conventional inhibitors or their derivatives. The reference oil, *bis*(2-ethylhexyl)sebacate, was selected because: it is typical of the various aliphatic diesters; it is one of the several higher-boiling diesters potentially useful as bearing lubricants for turbo-jet engines; and it was the most widely available aliphatic diester of requisite purity when this study was commenced.

The Apparatus

All the comparative data on antioxidants were obtained in an aeration-type oxidation apparatus using cold rolled steel, copper and dural as metal catalysts. Among the criteria used to denote the efficacy of the inhibitors were the extent of the induction period, the change in viscosity, colour, acid number, metal catalyst weight and appearance, and the presence of sludge and lacquer.

Of the antioxidants investigated, phenothiazine and a fluorinated derivative were found to be the most effective in nearly all the saturated esters at temperatures up to 175° C. For this reason phenothiazine was recommended for wide use in turbo-jet and turbo-prop engines. Esters containing a

double bond or a thioether linkage could not be inhibited against oxidation, even at 125° C.

An early report by other investigators that glutarate diesters were difficult to stabilise was followed up and it was shown that the difficulties had been caused by the use of impure glutarates. Glutaric acid diesters were found to be entirely satisfactory for lubricant applications. This finding was regarded as important, since large quantities of glutaric acid were expected to become commercially available in the United States.

Studies of the relation of ester structure to physical properties confirmed previous postulates that esters made up of relatively long flexible chains with a few suitably located short branches were required to obtain liquids with low freezing points (or pour points) and low temperature coefficients of viscosity. There is an optimum length for the branch chain if it is to lower the freezing point notably. A branch near the centre of the molecule causes a greater freezing point depression than one located nearer the end. Two short branches are more effective than a single long branch in this respect; in addition, a lower viscosity and higher V.I. liquid is obtained.

Freezing Points

For these reasons, the aconitic and the tricarballylic acid esters, as well as the esters of short chain polyhydric alcohols, would be expected to have lower viscosity indices than the better aliphatic diesters. The hexanoates of pentaerythritol, glycerol, trimethylolethane and trimethylolpropane have much higher viscosity indices than would be predicted from their structure. Lengthening the principal chain, when branching remains constant, results in increasingly higher freezing points. Thus the freezing point of dipropylene glycol dihexanoate is below −65° F, while that of dipropylene glycol dinonanoate is above −40° F.

It was demonstrated that amyl adipates with lower temperature coefficients of viscosity and lower freezing points than the pure symmetrical adipates or their mixtures could be obtained by esterification of adipic acid with isomeric mixed alcohols. An explanation for this, and an extrapolation to the property of other mixed esters, was advanced, based on the rheochors of such mixed esters. The use of adipates of mixed amyl alcohols was of particular value in the development and commercial production of synthetic lubricants for aircraft machine guns.

Many of the esters studied had properties making them suitable for a variety of new lubricant applications. Esters in the appropriate viscosity range for oils to be used in turbo-jets, hydraulic systems, instruments, and small mechanisms include trimethylolpropane trihexanoate, trimethylolethane trihexanoate, *bis*(3,5,5-trimethylhexyl)glutarate, *bis*(2-ethylhexyl)-3-methyladipate, *bis*-(C$_9$oxo)pimelate and glycerol trihexanoate.

Several esters in the low viscosity range of approximately 6 cs at 100° F appear suitable for use in the development of lubricants for light aircraft cannon, machine guns, and small arms. Among these are *bis*(2-methylpentyl)glutarate, *bis*(C$_9$oxo)pimelate, 1,5-pentanediol - *bis*(2 - methyl-pentanoate), 3-methyl-1,5-pentanediol - *bis*(2-methylpentanoate), and 3-methyl-1,5-pentanediol dihexanoate. In addition to these pure diesters, the mixed esters of butanol and ethylbutanol with adipic or with pimelic acid and the mixed ester of butanol, ethylbutanol and (oxo) amyl alcohols with adipic acid also showed promise.

These esters are also useful in a variety of other applications. All those mentioned above can be employed to produce greases formulated either with soaps or with copper phthalocyanine. Less volatile esters are also suitable for the production of storage-stable high-temperature greases using copper phthalocyanine as the gelling agent. Some can be used in formulating arctic crankcase oils either alone or blended with other synthetic or mineral oils. Because they possess both low volatilities and low freezing points, many esters have been found especially useful as 'base stocks' for the protection of greases. Superior gyroscope oils capable of operation over a wide temperature range have also been prepared.

References

1. Zorn, H., 'Esters as Lubricants,' US Air Force Translation Report F-TS-957-RE (1943).
2. Tingle, E. D., *J. Inst. Petroleum*, 1948, **34**, 743.
3. Horne, W. A., *Ind. & Eng. Chem.*, 1950, **42**, 2428.
4. Cohen, G., Murphy, C. M., O'Rear, J. G., Ravner, H., & Zizman, W. A., 'Further Research on Aliphatic Esters : Properties and Lubricant Applications' (TIDU 0385).
5. Murphy, C. M., & Ravner, H., 'Oxidation Characteristics of Some Diester Fluids,' NRL Report 3932 (1952).
6. Atkins, D. C., *et al.*, 'Synthetic Lubricants from Branched Chain Diesters,' NRL Report P-2576 (1945).
7. Murphy, C. M., & Ravner, H., 'Oxidation Inhibitors for Turbo-Jet Engines and Other High Temperature Lubricant Applications,' NRL Letter Report 3270-206/49 hl., 29 June, 1949.

IN THE EDITOR'S POST

The Retired Executive

SIR,—In the British Productivity Council Report on the heavy chemicals industry in US, the following phrase occurs:

'We should like to see more use made in Britain of those with high executive and technical experience after retirement from our chemical industry. There is much training, research, survey, committee and advisory work waiting to be done, of direct benefit to the whole industry, which many of those recently retired would be happy and well qualified to undertake and which would also provide lucrative employment to supplement their pensions.'

Chemical engineers and other executives might like to know of the Retired Executives (Employment) Bureau, mentioned in the *Daily Express*.

This Bureau has been licensed by the L.C.C., and its aim is to provide interesting and remunerative employment—mainly part-time—for those retirees with specialised skills and experience. Part-time employment may range from membership of a group of experts with complementary skills, advising a group of firms in any locality, to the indexing of technical periodicals, or compiling correspondence courses, without leaving home.

No callers yet, please, but we shall be glad to hear from retirees or employers who are interested in this work.

Yours faithfully,

Group Captain G. W. WILLIAMSON.
12 James Street, W.C.2.
Tel.: Covent Garden 0202.

New Plastic Film

CLAIMED to be the strongest of all plastic films, 'Mylar' is now being manufactured by E. I. Du Pont de Nemours & Co. at a new plant at Circleville, Ohio, USA. It is a transparent polyester film and is produced in various thicknesses.

It is claimed to have a tensile strength of 23,500 lb. per sq. in., about one-third that of manufactured steel, and an impact strength almost twice that of any known commercial film. It is also said to be resistant to moisture and grease and proof against gases, acids and alkalis. The film is stable from −60° C to 150° C. It is also being distributed in Canada.

I.C.I. Hope to Equal Record

FORECASTING that record figures established in 1952 would be equalled in 1954, Mr. A. T. S. Zealley, a member of the main board of I.C.I., told the Billingham Foremen's Association last month: 'This year the company is doing extremely well. We had a good year last year, but we are going to do even better this year in all directions. We haven't reached the record figures of 1952, but I feel confident that by the year's end we shall.'

Export sales, he continued, were rising, and home sales for October reached an all-time record. Wilton was the largest construction programme in the history of I.C.I. and one of the biggest in the world.

Mr. Zealley, whose speech is reported in the January issue of *The Tees-Side Journal of Commerce*, said that few other companies had been able to hold prices of their products to the same extent as I.C.I.

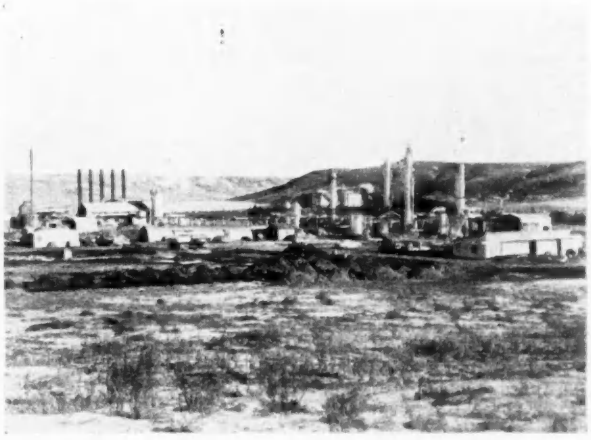
The company, he said, was spending at the rate of £25,000,000 to £30,000,00 on new capital investment, but the amount that could be saved from the surplus—about £11,000,000 in 1953—was not enough to finance all the new ideas from the development and research departments. The appeal made to the public, however, had raised £30,000,000 with great ease.

Jobs for Ex-Officers

A VOLUNTARY organisation designed to help ex-officers of the Armed Forces, The Officers' Association, maintains an employment bureau on the register of which are the names of a large number of ex-officers of the Royal Navy, the Army and the Royal Air Force, all of whom wish to obtain civilian employment.

These ex-officers vary in age, experience and technical qualifications but include senior retired officers of all three Services very suitable for administrative posts. Among these senior officers are men of wide experience who have held some of the most responsible appointments in the Services.

A special bureau has been set up located at The Officers' Association, 28 Belgrave Square, London, S.W.1, which deals especially with these senior officers. The director of the bureau, Major-General Sir Maurice Dowse (SLOane 7182 Extn- 10), would welcome inquiries from any employer.



In the picture the heater converters of the Jumping Pound sulphur plant (see story below) are shown on the far left with the boiler house with its five stacks in the left centre. On the right are the processing towers which recover natural gasoline and purify the natural gas for industrial and domestic use

Extensions Almost Complete

LAST autumn we described the Shell plant for extracting sulphur from natural gas at Jumping Pound, Alberta, Canada (THE CHEMICAL AGE, 1954, **71**, 769), and mentioned that a $500,000 extension was being built. This work is now almost complete and within a few days production will be almost trebled; the daily output will go up from 32 to 80 tons.

Some time ago a $1,500,000 expansion of natural gas facilities in the Jumping Pound area was undertaken by Shell Oil Co. of Canada Ltd., and since last November the enlarged plant has been producing 60,000,000 cu. ft. of purified and dehydrated gas per day for the city of Calgary (which is some 35 miles away), the internationally famous holiday resort, Banff, and other towns in the area. Previous daily output was 35,000,000 cu. ft.

The sulphur, which is 99.9 per cent pure, hitherto has all been sold to pulp and paper mills in western Canada and the US. Now a substantial quantity will be shipped 800 miles north to the Gunnar Mines at Beaver Lodge on the shores of Lake Athabasca in Saskatchewan. Here it will be converted into sulphuric acid for processing uranium ores.

French Steel Output Record

French steel production reached a record figure of 1,012,000 tons in December. This compares with 955,000 tons in November. Total steel output during 1954 was 10,625,000, an increase of 6.25 per cent over 1953.

Looking Ahead

PROSPECTS for the US chemical industry during 1955 were outlined by Mr. William C. Foster, President of the MCA, when he spoke at a business forecast seminar in Washington, DC, recently.

Looking first at the immediate past, he said that the industry, one of the fastest growing in the country, continued its expansion during 1954, completing slightly more than $1,000,000,000 worth of new construction projects. Under construction or definitely planned was another $1,514,000,000 worth to be completed by private enterprise within the next three years and $3,360,000,000 worth financed by the Government.

Sales should closely approximate the record figures of 1953 and, if the general economy was maintained on a generally good basis, the new productive capacity indicated still higher sales in 1955.

Prices of chemicals and allied products, according to government sources, were 1/10 of 1 per cent higher in September, 1954, than in September, 1953. Prices of drugs and pharmaceuticals and fertilisers showed a decline.

'One of the questions we were asked to cover today was price changes in 1955—whether they'll go up or down and how much,' Mr. Foster went on. 'My answer to that is: I certainly wish I knew! Barring an inflationary situation, the efficient production of goods by the plant brought on-stream in recent years should indicate lower unit costs.'

A Patron of the Arts

Shell Organises Exhibition of Paintings

A MOST interesting exhibition of paintings and drawings by young British, French, Italian, Dutch, Swiss and German artists, has been running at the Galleries of the Royal Society of Painters in Water Colours, London, since 12 January. The exhibition, entitled 'The Artist's View of an Industry' closes at 1 p.m. today (22 January). All 90 of the paintings have been bought by the Shell Petroleum Co. Ltd. and were made at the invitation of the company.

A considerable number of painters, the majority young and not yet established, were invited by Shell to submit paintings, drawings or lithographs dealing with the oil industry. No restrictions were imposed on style or treatment. The artists were given the opportunity to visit refineries, installations, storage depots and research centres and to choose their own topics.

Many Different Subjects

The subjects chosen clearly showed the freedom allowed, for while there are several paintings of refineries both by day and by night, the artists painted petrol stations, jetties, bitumen plants, Horton spheres, oil tankers, rail tank cars, petrochemical plants, research equipment, a drum storage yard, mazes of pipes, etc. One or two artists appear to have just closed their eyes and smeared paint on canvas. One such painting was called 'Forces that Exist' by Bernard Cohen and another was called 'Oil Plant—Pipes' by Arturo Carmassi of Italy. 'Station La Nuit' by the French artist, M. Devoucoux; 'Refinery' by Diana Cumming; and 'Oil Worker' by Luciano Miori of Italy; were especially pleasing. There were, however, many others which showed skill and imagination and the exhibition, on the whole, was well-worth attending.

Shell arranged for the exhibition in the belief that the artist has his own special part to play in the interpretation of the vital industries to the public. The company's films and photographic exhibitions have done a great deal to foster understanding of the industry among the public and this exhibition will now also play its part.

A committee consisting of Sir John Rothenstein (Director of the Tate Gallery), Professor William Coldstream (Slade Professor at University College, London), Mr. Robin Darwin (Principal of the Royal College of Art), Mr. Philip James (Art Director of the Arts Council) and Mr. Robert Lyon (Principal of the Edinburgh College of Art) advised on the selection of the artists and later chose the works on display at the exhibition.

Hopeful Future

Billingham Chairman's Review

IN a review of the Division's progress during 1954, Dr. G. I. Higson, chairman of Billingham Division of I.C.I., says the year was one of notable achievement and preliminary figures for the Division as a whole indicated that many records had been broken.

Dr. Higson, who is to retire at the beginning of February (see THE CHEMICAL AGE, 1955, **72**, 194), writes in a recent issue of *The Billingham Post*, the Division's house journal: 'We started 1954 with every reason for optimism yet with the sobering knowledge that expanding competition would allow of no slackening of effort. Our optimism was justified. If 1953 was a year in which we fought our way out of a trade recession, 1954 has been a year of consolidation and expansion.

'In a highly competitive market increased output is not enough. What matters is output per man—or what we know by the now-familiar word productivity. Sound planning, technical and mechanical efficiency, safe practices and many other factors contribute to this, but the overall effect has been a steady rise in the output per man to enable the Division to hold its place proudly among the most successful in the company and help it against competition.

'In conjunction with higher productivity, the increasing acceptance of work study has meant that more employees have had the benefit in their wage packet of this increased prosperity—a prosperity of which the operation of the profit-sharing schemes in the coming year will be a further reminder.'

After referring to extensions that have taken place at Billingham in the past year, Dr. Higson writes: 'We can look to the future with every justification for optimism. Demand for our products runs high and with the expansion that has taken place in the past year we have confidence that not only can we hold our own in the markets we have secured but that we have an outlet for our increased production capacity.'

Vinyl Emulsion Paints

Ways of Overcoming Conflicting Requirements

DR. C. Bondy lectured to the London Section of OCCA on Thursday, 13 January, on 'Theoretical & Practical Aspects of Vinyl Emulsion Paints.' He correlated some of the facts which had been worked out in the design of emulsion paints and discussed a theoretical background for some of the more notable which characterised those paints. A constantly recurring main theme, said Dr. Bondy, was compromise between the conflicting requirements of the materials; he elaborated to some extent the conflicting trends and discussed how the compromises could intelligently be approached.

In this country the resins which had found acceptance for application to vinyl emulsions were comparatively few. The chief one was polyvinyl acetate, with polystyrene or styrene copolymers a rather slow second. The acrylics were the third candidate, but they had not intruded very far into the British technical field.

Summarising the differences that might be expected between these resins, he said the chief advantages of polyvinyl acetate, which had been utilised very successfully in the design of emulsion paints, were connected in the first place with its very high pigment binding capacity. A further prominent feature was the high scratch and abrasion resistance of the flexible polymer films. And for a particularly important application of emulsion paints, on fresh walls, fairly green plaster, green concrete, and so forth, where a lot of water was still present in the substrate layer, the high moisture permeability of polyvinyl acetate was an important feature.

Distinguishing Features

An important feature of emulsions with polystyrene or styrene copolymers was that as a rule they were of much finer particle size. That was not a necessity, but was something which could be achieved with those resins and it was difficult to achieve anything like the same degree of fineness with polyvinyl acetate. Connected with this was the property of high gloss on the emulsion films, higher than could be achieved with polyvinyl acetate. Another feature which distinguished these resins from polyvinyl acetate was adhesion to smooth surfaces under conditions of high humidity. Connected usually with the smaller particle size and with the much more hydrophobic nature of the polystyrene or styrene copolymer resins was that they tended to dry down to a film of much higher water and water spotting resistance.

The pigment-binding capacity and general handleability of polystyrene and styrene copolymer emulsions were perhaps not quite so attractive to the manufacturer as were those properties with polyvinyl acetate. The fact that the styrene copolymers and polystyrene were virtually unsaponifiable inert materials could again in some cases give an advantage, although surprisingly the polyvinyl acetate resin was really very resistant to hydrolysis.

The Acrylics

In this country the acrylics were still somewhat a rarity and even a curiosity. In his opinion they occupied a place almost intermediate between polyvinyl acetate and polystyrene in respect of their behaviour as emulsion polymers as well as binders in the paint system. One of their very obvious disadvantages was high price.

When fine particled emulsions were used for making paint they must be completely stable against coagulation, and that meant almost invariably that they must be stabilised. The manufacturer and user of the emulsions must make a compromise between the requirements of good water and water spotting resistance, adhesion under most conditions, stability against coagulation, and so on. Stability was a necessary requirement if the manufacturer were to produce a fine particle emulsion.

Also in connection with particle size, normally a compromise would have to be made between the properties which appertained to a very fine particled material, which usually meant high gloss and very good film formation, but quite frequently impaired flow, undesirable rheological properties and possibly even instability. One could not carry the sub-division of the polymer too far without endangering the stability of the emulsion.

Both types of resin required plasticisation

in order to be flexible, and plasticisation was also necessary for the quite separate purpose of film integration. The plasticiser helped the pigment and resin particles to fuse to a homogeneous whole. It was not always possible to add to the resin an amount of plasticiser which would induce adequate film integration without inviting a lot of trouble, and therefore it was common practice to eke out the film integrating efficiency of plasticisers with solvents which would fulfil their function for only a limited time, very often only a few hours, or perhaps days, and would then disappear and leave the integrated film in a state of adequate flexibility.

An Important Problem

Probably the most important problem confronting the maker of emulsion paints was the preparation and the dispersion in the water of the pigment and extender which formed the basis of the paint. Dr. Bondy discussed in some detail the grinding and other factors necessary in that preparation and dispersion.

In order to achieve a really adequate dispersion in the pigment grind, he said, it was usually considered desirable to grind in the presence of a hydrophilic colloid. Experiments carried out in his organisation had revealed something which had probably been met with in many laboratories, but might not have been brought to daylight, namely, that for optimum efficiency of dispersion it was desirable that the hydrophilic colloid used in making a pigment dispersion should be of comparatively low molecular weight. In all probability this was linked with the fact that the chief pigment used in emulsion paints was titanium oxide, which had a considerable surface area; one could assume that 1 g. titanium oxide had a surface area of 2-5 sq. m.

One would aim at as complete a de-flocculation as possible (the ideal of a completely de-flocculated paint was actually not achievable in practice), the highest obtainable opacity, gloss and water resistance and the best film integration in the emulsion paint system, but he went on to show that that desirable state of affairs was counterbalanced by some undesirable features.

Discussing the application of emulsion paints to porous surfaces, Dr. Bondy said that if one tried to apply a concentrated emulsion paint to such a surface the result would almost invariably be poor unless precautions were taken; the surface would remove the water from the paint at such a rate that the dispersion would coagulate almost under the brush, it would fail to integrate to a proper film and would fail to adhere. One of the most obvious remedies, which was frequently used, was the application first of a very highly watered dilution of the same emulsion paint. Unfortunately he had found that quite a number of manufacturers recommended a degree of dilution of the paint for that purpose which in his opinion was insufficient.

In experiments he had made, paints which were designed to give egg-shell gloss, i.e., with a pigment volume concentration of about 28-30 per cent, if diluted with at least five times their own volume of water would be sufficiently de-flocculated to stop the pores. If such precautions were not taken, one might find that the pores were just covered with a lump of pigment-cum-resin which was insufficient to stop the penetration of water. One needed to provide particles small enough to penetrate into the pores.

Probably the easiest way, and very often it was quite sufficient, although it was frowned upon by the manufacturers, was to saturate the wall with water. Many manufacturers insisted that plaster walls or plaster rendering should be dry before the paint was applied. Dr. Bondy believed the opposite to be true. If the wall were dry, one should flood it with water completely before the emulsion paint was applied, and then one obtained not only good adhesion, but quite a lot of improved wet edge properties and generally much easier working. Probably the best way would be to flood the wall with a dilute emulsion paint, and then one would get the best of both worlds.

Corrosion Remedy

With regard to the storage of the paint in the can, aqueous media naturally had a tendency, even in the best conditions, to corrode steel or even tinplate. The usual remedy of adding anti-corrosion agents had been applied very successfully, although perhaps not so successfully as one might have hoped. The development of vapour-phase inhibitors for quite a different purpose had given rise to the idea that they could be used with equal success invariably in aqueous media, but the idea was not justified. He discussed briefly some of the inhibitors and their merits and de-merits.

Another problem was that of preventing mould growth on aqueous systems. For really complete protection one would probably have to resort to heavy metals, possibly combined with the protection given by fluorides. But it was very difficult at all times to design a system which would be immune from attack by all possible moulds or fungi. The problem had not been very serious, except where emulsion paints were used in the tropics.

In the ensuing discussion Dr. H. J. Stern said that for many years thin-walled rubber articles were made by forming a film from rubber solution. Later such articles were made from natural rubber latex, which in many ways could be considered analogous to the emulsions which formed the basis of emulsion paints. An early disadvantage of the films deposited from latex was found to be their high water absorption, due to the non-rubber constituents. The properties of these films were found to be improved very much by leaching, washing out the soluble materials with water and drying again. He wondered whether anything of that kind occurred with the emulsion paint films. For example, if one examined the extent of water absorption by a film, then dried it and examined it again, one would expect a progressive decrease in water absorption.

He could not follow the reason for the advantages gained by applying emulsion paints to wet walls. He asked if there were leaching on the inside of the film that was formed, the water in the wall tending to take away some of the soluble matter from the film. If that were so, the washing of the walls should give improved results.

Improvement By Water

Dr. Bondy, dealing with the improvement of water absorption properties by washing, said he believed the phenomenon was perfectly familiar to all users and makers of emulsion paints. One would not expect a decorator to flood one's living room with a hose; but where the paints had been used out of doors the exposure to rain had not made them worse, but better. There was certainly a possibility that the swamping of a wall with water would help to leach out some of the water-soluble materials. A porous surface helped by extracting water which contained the water-solubles, and therefore the water resistance of the paint on a porous substrate was usually better than that of the paint on a non-porous surface.

Mr. G. C. Huist, commenting on the washing of emulsion paints and the removal of water-soluble materials, recalled Dr. Bondy's quite correct advice to use emulsion paints on new plaster and pointed out that, when that was done, the soluble salts were actually forced through the emulsion paints; so that the reverse of washing out the soluble salts occurred.

Efflorescence

Dr. Bondy replied that the problem of efflorescence of fresh plasters was important and many remedies had been suggested. If one adopted the practice of fairly extensive wetting out of the wall with water combined with emulsion particles to seal the pores, the efflorescence effect could be very much minimised. One might even think of remedies which would be rather unorthodox, such as the addition of crystallisation inhibitors like amino acids, or of ammonium carbonate to precipitate the free lime. But he did not think one could make a universal recommendation, and he felt that it was rather dangerous to generalise and to recommend that the paint should be applied to a dry surface.

Mr. G. E. Mack said he was not very much in favour of the idea of plugging up the pores with 'billiard balls.' The pores were very often formed by needle shaped crystals. He also pointed out that size was a very good priming medium.

Dr. Bondy agreed on the whole that a proper choice of size to give the properties required would provide an admirable solution. But he was not sure that he agreed with the billiard ball conception. Micrographs of plastic emulsions, published in *Industrial & Engineering Chemistry*, showed that there was a tendency to deform quite readily to the shape of the surrounding matrix; so that in all probability the billiard balls would very quickly assume the shapes required in the matrix, usually formed of needle shaped plastic crystals.

Mr. G. E. Mack, proposing a vote of thanks to Dr. Bondy for his paper, said it marked quite a step on the way from the 'cookery book' manufacture of emulsion paint to the time when he hoped the manufacturers of paint would be wholly scientific and, perhaps even more, that those who put it on walls would be thoroughly scientific.

Licence Controls

Changes for Export & Transhipment

CHANGES in export licensing control are made by a Board of Trade Order which came into force on 17 January. From that date most exports to Hong Kong are freed from control. Controls over exports to China remain unchanged and no relaxations have been made in the embargo list operated by the United Kingdom and Hong Kong.

A wide range of goods for destinations other than China, Macao and Tibet are freed from control and certain items of strategic importance brought under control. In the main, these changes stem from the revision of strategic controls announced in the House of Commons in July last, but a few alterations are consequent upon the removal of licensing controls no longer needed on goods which were in short supply.

The principal changes are as follows:—

(1) Licences are not now required for the export to Hong Kong of goods other than for those requiring licences to all destinations.

(2) Apart from exports to China, Macao and Tibet, licences are not now required for among others, certain lubricants, certain petroleum oils and mixtures of oil, certain forms of plastic materials, sulphur, certain types of metals and hard metal powders, sulphur burners and pyrites furnaces, certain electronic and precision instruments, specified synthetic rubber and specified chemicals.

(3) Licences are not now required for the export to the British Commonwealth, the Irish Republic and the United States of America of aluminium and aluminium alloy in powder form.

(4) Licences are now required for the export to all destinations other than the British Commonwealth, the Irish Republic and the United States of America of certain hydraulic fluids, titanium carbide, etc.

(5) Licences are now required for the export to all destinations of certain forms of iron and steel containing nickel, specified chemicals and radio-active substances, etc.

Transhipment

Consequent upon changes in export licensing control, the Board of Trade have issued a revised Transhipment Open General Licence which operates as from 17 January, and which supersedes that of 5 May, 1954.

Among principal changes are the following:—

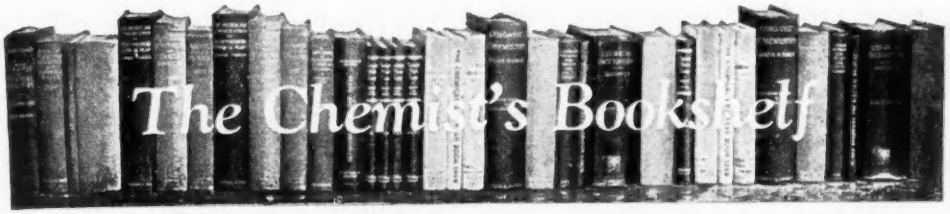
(1) Individual transhipment licences are no longer required for coke, certain petroleum oils, boron carbide, silicon carbide, asbestos, carbon, natural graphite, graphite scrap, mica, certain plastics, quartz, silicone greases, aluminium (other than powder), certain aluminium alloys, cerium, certain ferro-alloys, bismuth and bismuth alloys, cadmium, calcium, strontium, vanadium and vanadium alloys, strontium and vanadium ores and concentrates, certain platinum pipes and tubes and platinum wire, certain pumps and valves, air-conditioning machines, water treatment machinery and plant, certain steel strip tinning plant, sulphur burners, unvulcanised mixtures of rubber, certain synthetic rubbers, densitometers, dynamometers, certain industrial furnaces, micro-hardness testers, mineral separation plant, *p*H meters, strain gauging equipment, Warburg apparatus and certain chemicals.

(2) Individual transhipment licences are no longer required for goods destined for Hong Kong.

(3) Individual transhipment licences are now required for the transhipment to all destinations other than the British Commonwealth, the Irish Republic and the United States of America of various goods, including the following: certain additives for diesel oils, certain hydraulic fluids, ester type synthetic lubricants, certain plastic materials, silicone fluids, certain nickel steel alloys, certain magnesium alloys, specified magnetic materials, mercury, certain titanium alloys, specified nickel wire mesh, beryllium ores and concentrates, platinum clad molybdenum pipes and tubes, silicon of a specified purity, tungsten and tungsten alloy wire and filament, specified chemical and petroleum plant and equipment, certain carbon black furnaces, specified chemicals, certain scientific equipment and specified munition machines.

Pharmaceutical Assembly in London

London has been chosen as the centre for the 16th General Assembly of the Fédération Internationale Pharmaceutique, which will be held from 19 to 23 September. Arrangements for the meetings—to be held at Senate House, London University—are being made by the Pharmaceutical Society of Great Britain. The FIP last met in London in 1923.



OXINE & ITS DERIVATIVES. Vols. I & II. By R. G. W. Hollingshead. Butterworths Scientific Publications, London. 1954. Pp. x + 322, xix + 294. 42s. each volume.

The first two volumes of this three volume treatise covering every aspect of the chemistry, properties and uses of 8-hydroxyquinoline and its derivatives deal with the parent compound alone; the final volume, yet to be published, describes its numerous derivatives. 8-Hydroxyquinoline is probably the most widely used organic analytical reagent; it is certainly the most catholic in its reactions and these properties have confronted the author with a formidable task. The manner in which this task has been executed cannot be too highly praised and the result is a book which will be accepted as a standard work of reference for many years to come.

It has been conceived in the form of an authoritative non-critical survey and so must not be considered as a collection of tried standard analytical routines which may be followed without further question, but rather as a guide to possible methods. The review has been as comp'ete as possible, many references are quoted from the most unfamiliar journals and an appendix at the end of Volume II gives a list of references which became available after the manuscript was submitted. This makes the coverage complete up to the date of publication.

The material has been divided into 34 chapters, 27 of them devoted to the analysis of a metal or group of metals using the reagent. The first three chapters discuss the preparation and the physical properties of oxine together with specifications for its purity. There follows a brief account of the analytical uses of the reagent. The final three chapters deal with the determination of phosphate and of silica, the removal of interfering metals in the analysis of beryllium and the non-analytical uses of oxine. Because of the marked biological effects of traces of metals and the ability of the reagent to co-ordinate with them, these effects are diverse and range from fungicidal activity to the stimulation of enzyme activity.

The completeness of the information supplied in this treatise may be assessed by reference to the appendices at the end of Vol. II, which provide figures for the drying temperatures recommended for metal oxinates, the *p*H range for complete precipitation of metal oxinates, the *p*H range for complete extraction of metal oxinates with organic solvents and the wavelengths of maximum absorption of chloroform solutions of metal oxinates. This work should be at the disposal of every analytical chemist.—J.R.M.

FROM CLASSICAL TO MODERN CHEMISTRY. By A. J. Berry. Cambridge University Press, London. 1954. Pp. xii + 251. 25s.

Any account of the history of chemistry can be made more palatable by copious reference to the personalities of famous chemists and incidents in their lives. Such material does not find a place in this book. It is therefore much to the author's credit that he has nevertheless produced an interesting and readable work. His approach, a very good one indeed, is to trace the development of a limited number of topics separately over the last century and a half.

The chapters on 'Physical Optics and Chemistry,' 'Molecular Magnitudes' and (less so) 'Analytical Chemistry' represent admirable historical sketches, bearing in mind that sketches cannot be criticised for omissions. At more than one point in the first of these the author overrates Armstrong's quinonoid theory of colour. Baeyer and also Willstätter drew attention to the necessity for auxochromes in both quinonoid and benzenoid rings. This was later expressed in terms of resonance by Bury.

The title of the book is not particularly apt. The classical period in chemistry is not easy to define. In inorganic it probably occupied the first half of the nineteenth century, in physical perhaps 40 years later and in organic from 1860 to 1920. In develop-

ing most of his topics, however, the author goes back well into the eighteenth century. Thus in the chapter on electricity and electrolysis he starts even before Galvani's experiments (1790), devoting some space to the work of Cavendish (1773-1783) largely unpublished at the time. The latter date, incidentally, is wrongly given as 1871. In this short chapter of 34 small pages the work of Wollaston, Faraday, Helmholtz, Maxwell, Nernst, Hittorf up to that of Lowry and Brönsted among others is mentioned. It will be obvious that such treatment can hardly do justice to the subject matter.

The chapter on formulae omits Dalton's symbols but discusses in rapid succession and much too briefly the systems of Berzelius, Gmelin and Kolbe, the theory of types, organic radicals, valency, Wurtz's crossed symbols, the quadrivalency of carbon, graphic formulae of Loschmidt, Frankland's law of even numbers and Kekulé's benzene formulae. Tridimensional formulae are acknowledged in four sentences followed by an abrupt jump to tautomerism, which is dealt with in one sentence.

The topics selected are mainly physical and general; organic chemistry receives little attention. Apart from the three chapters first referred to, which are each well-written essays on clearly defined topics, the general style is unfortunate. The quick switch from one item to the next and the haphazard choice of points to mention gives an uneasy, disjointed and erratic progression.

It would be something to look forward to if the author with his deep sense for the historical and his profound appreciation of the significance of isolated discoveries great and small would write the more leisurely book of which this one is but a précis.—M.C.

INORGANIC CHEMISTRY. By Fritz Ephraim. Edited by P. C. L. Thorne & E. R. Roberts. Oliver & Boyd, Edinburgh. 6th English edition. 1954. Pp. xii + 956. 35s.

The presentation of the fundamental facts of inorganic chemistry in a systematic, logical and readable fashion, within the compass of a text-book, requires no little skill on the part of the author. In addition, within any modern text-book of inorganic chemistry the proper and suitable physical chemical background must be selected and developed, otherwise the book is likely to become a volume of disjointed facts.

In 1926 the first edition of 'Ephraim' appeared, and from the start it satisfied the above requirements in a very special way. With each new edition its popularity has increased, because it has always sought to present progress in inorganic and physical chemistry, within its pages, in a manner related to the established facts and, at the same time, to make the facts of inorganic chemistry logical and understandable.

This sixth edition follows in the tradition of the earlier volumes. There is evidence that the fifth edition has been carefully revised. For the reader unfamiliar with 'Ephraim' it may be stated that he will find the arrangement of the subject matter, an outstanding feature of the book, different from most text-books of inorganic chemistry. The work is divided into six sections. The first section contains the physical chemical approach necessary for the understanding of inorganic chemistry and underlines the keyword of modernity in this book because its chemistry begins with the Rutherford-Bohr atom. Other important topics in this section are the periodic system, radioactivity and isotopes, and modifications of elements. The following sections discuss, in succession, the chemistry of (a) halogen compounds, (b) oxides of hydrogen and the metals, (c) compounds of sulphur, selenium, tellurium, (d) the nitrogen, phosphorus, arsenic group of elements and (e) boron and the elements of the fourth group.

The advanced student studying for examinations in chemistry will appreciate the imparting of collateral information in juxtaposition so that chemical facts and theories may be viewed as a whole.

For the student conversant with 'Ephraim' it can be stated that the chapters on valency and radioactivity have been largely rewritten in the light of modern knowledge of the subject. Small additions have been made throughout the book, making 956 pages in comparison with 939 pages in the fifth edition, and an extensive selection of literature references is supplied.

This book has a plan; it displays neither history nor stories of human interest. Critical acumen has gone into the collection and selection of material. The clarity of style and the quality of the typography make for ease in reading. At 35s. it is 3s. dearer than the fifth edition, but in a world of rising prices this is more than offset by the quality of the purchase.—R. J. MAGEE.

HOME

Four Years for Cashier

Sentence of four years' imprisonment was passed at the Old Bailey on 5 January on Stanley Alfred Matthews, 50-year-old cashier of London Road, Hadleigh, Essex, for falsifying the accounts of his employers, W. J. Bush & Co. Ltd., chemical manufacturers, of Hackney. It was stated that the deficiency was more than £9,000 but Matthews had covered up for someone else.

Wage Minimum Sought

The national executive committee of the Chemical Workers' Union stated on Monday, 17 January, that the union would demand a minimum wage for all adult male process workers of £8 a week, with 80 per cent of this for all women workers, and proportionate rates for juveniles. They would also claim the principle of equal pay for equal work and a national wage policy to replace the system of collective bargaining.

Silicones for Industry Exhibition

An exhibition of the history, production and application of silicones is to be held at the Chamber of Commerce, New Street, Birmingham, from 28 February to 5 March. Invitations can be obtained from Midland Silicones Ltd., 19 Upper Brook Street, London W.1. The exhibition, entitled 'Silicones for Industry' will include a film show. It will open at 2.30 p.m. on the first day and close at 4 p.m. on the last day. On other days it will be open from 10.30 a.m. to 6.30 p.m.

Applications of the Complexones

A lecture accompanied by practical demonstrations on 'The Complexones and their Analytical Application' to be given by Professor G. Schwarzenbach of Zurich University is announced by the Society for Analytical Chemistry. It will be held in the lecture theatre of The Royal Institution, 21 Albemarle Street, London W.1, at 6 p.m. on Wednesday, 2 February.

Caribbean Colours

Princess Margaret, Patron of the British Colour Council, has sponsored three colours in connection with her visit to the Caribbean Islands. They are Carribbean Gold, Bermuda Blue and Sugar Cane. A special card illustrating the colours will shortly be available.

Record Steel Production in 1954

Steel production in 1954 was 18,520,000 tons, an increase of 911,000 tons over the previous highest year's output in 1953. In 1955 capacity will be available for production to rise to 19,500,000 tons. Weekly average output in December was 354,700 tons, less than in November but considerably higher than the previous best December of a year ago. Production of pig iron in 1954 was 11,883,000 tons, compared with 11,175,000 tons in 1953.

Winning Suggestion

Mr. Denzel Howard, 36-year-old shift foreman on a distillation plant at Petrochemicals Ltd., Carrington, has won £50 worth of savings certificates in the firm's 'productivity pay off' competition. His idea was to make better use of the water supplied by a change in the circuit on the cooler and distillation plant. It was the best suggestion of the year for stepping up production or cutting costs.

DSIR Liaison Officer

An information liaison officer has been appointed by DSIR to the Hillington industrial estate in Scotland. He will be there one day each week, or oftener as required, to meet representatives from the many firms on the estate and put them in touch with the research or other bodies that can help them with their problems. Designed to bring the benefits of research to smaller firms, this project is the first of its kind in Great Britain. If it is successful, it will be repeated in other industrial estates in Scotland.

New Firms in Scotland

The oil, colours and chemical industry in Scotland tops the list of new company registrations for 1954 with a total of £2,063,650 as against only £190,950 subscribed for new companies in the previous year. This immense addition and the placing of these industries in first place, stems from the registration of Scottish Oils which acquired the Pumpherston Oil Co. Ltd., the Oakbank Oil Co. Ltd., Youngs Paraffin Light & Mineral Oil Co. Ltd., and other subsidiary interests, in a new company registration valued at £2,000,000.

• OVERSEAS •

Reconstruction in North Korea

Two Russian chemists and nine Polish building experts have arrived in Pyongyang to help in North Korean reconstruction work, according to the North Korean radio.

More Phosphates from Negev

The extraction of phosphates in the Negev (Israel) doubled in 1954 compared with 1953, and the total amount of phosphates extracted in the Negev since 1951 has been approximately 100,000 tons. During 1955 it is expected that about 140,000 tons will be extracted.

New Catalyst in Holland

The Koninklijke Nederlandsche Zwavelzuurfabriek NV (Amsterdam) is planning to build installations for making a new type of catalyst for the petroleum industry, which is not yet produced outside the USA. A licence agreement has been concluded with the American producer.

Indonesian Oil Project

Standard Vacuum Oil Company plan a big expansion programme in Indonesia, which would need an investment of between $70,000,000 and $80,000,000 and includes the construction of a 90-mile pipeline to tap the new Lirik oilfield in Central Sumatra. This would make crude oil from this field commercially available for the first time.

Platformer for Venice Refinery

Another platforming unit is to be added to the six such units being built or in operation at the BP Group's refineries at home and abroad. This seventh platformer is to be built at Porto Marghera Refinery, Venice, which is jointly owned by British Petroleum and Azienda Generale Italiana Petroli. It will have a capacity of about 75,000 tons a year. British Petroleum's first platforming unit to be commissioned in the United Kingdom is to come into operation next month at Kent Oil Refinery on the Isle of Grain. The platformer at the company's Llandarcy Refinery, South Wales, is due to be commissioned during April. Platforming units are already in operation at the BP Group's Aden, Lavera (France) and Hamburg Refineries, while one is virtually complete at Kwinana, Western Australia.

Better Butter

Dimensional Products Co., of New York, sells a new butter dish with a built-in chemical unit in the base. The unit automatically keeps the butter from melting on the table or getting too hard in the icebox.

Japanese Aluminium for Britain

The first shipment of aluminium from Japan to the UK since 1952 will be made shortly. Japanese manufacturers have concluded a contract to export 1,000 tons of primary aluminium to Britain, and a further 2,000 tons to Argentina.

More Mercury—But Still not Enough

Production of mercury at the Almaden, Spain, mines rose during 1954 to 42,265 flasks, it is reported. This is twice the normal output, but is still short of the 80,000 flasks the US defence production authorities hoped would be reached. The new distillation furnaces, it is said, have not come up to expectations and there have been heavy losses of mercury in smelting.

UK Firms May Build Indian Steelworks

The Indian Government has agreed that a British technical team should visit India to prepare a project report on the construction of a steelworks there. The team is expected to represent the British Government as well as the commercial interests involved in the Metallurgical Equipment Export Company, which consists of Davy and United Engineering, Electric Furnace, Head Wrightson, Joseph Parks & Son, Simon Carves and Wellman Smith Owen Engineering.

Pfizer in Far East

Chas. Pfizer & Co. Inc., the American pharmaceutical firm, announces that a new plant for producing the antibiotic drugs, terramycin and tetracyn, is being prepared on the outskirts of Manila in the Philipines, and is due to start operating in the early spring. Other plans for the Far East include a long-term programme for Korea, where for the first time a private pharmaceutical firm will undertake a scheme to bring the doctors and people there the latest information about medicine, antibiotics and pharmacy.

· PERSONAL ·

PROFESSOR D. H. R. BARTON, Ph.D., D.Sc., A.R.C.S., D.I.C., F.R.I.C., has been appointed Regius Professor of Chemistry in Glasgow University in succession to PROFESSOR J. W. COOK, Ph.D., D.Sc., Sc.D., F.R.S., F.R.I.C., who has resigned to become Principal of the University College of the South West. Professor Barton has been Professor of Organic Chemistry at Birkbeck College, London University, since 1953.

MR. JOSEPH WALTON is retiring from the joint managing directorship of Thos. W. Ward Ltd., Albion Works, Sheffield, on 31 January, but will still be available in a consultative capacity and will retain his position as chairman and managing director of the Darlington Railway Plant & Foundry Co. Ltd., Darlington. Mr. Walton became a local director of Thos. W. Ward Ltd. in 1927, was made a full director in 1937, and was appointed joint managing director in 1950.

Less than a year after taking up a new appointment as general manager, MR. G. E. H. HALL, A.M.I.Prod.E., has been appointed a director of Sheepbridge Stokes Ltd. and also director of British Van der Horst Ltd., Chesterfield. MR. R. GORE, A.M.I.Mech.E., A.M.I.Prod.E., is now general manager of the engineering division of Sheepbridge Equipment Ltd., and MR. C. HAND has been appointed general manager of the foundry division. MR. J. R. JENKINS has been appointed methods engineer for the Southern Group of Sheepbridge Companies. MR. E. A. MACDONELL is now southern area sales representative for Automotive Engineering Ltd., of Twickenham, and MR. F. W. SIMMONS has become manager of the London branch of Sheepbridge Engine Repairs Ltd.

MR. ALEX LAZARUS, former managing director of Chemitrade Ltd., has joined the Propane Co. Ltd.

The administrative council of the Société de Chimie Industrielle has elected M. FRANÇOIS BOUDART as president. M. Boudart, who is president of l'Union Chimique Belge and the Federation des Industries Chimiques de Belgique, succeeds M. ROBERT BIENAIME who has been elected vice-president and chairman of the executive committee. Associated with numerous Belgian chemical firms, M. Boudart is one of the oldest members of the Société de Chimie Industrielle and received its grand medal in 1954.

MR. J. E. C. BAILEY, C.B.E., chairman and managing director of Baird & Tatlock (London) Ltd. and Hopkin & Williams Ltd., manufacturers of scientific instruments, laboratory furnishings and fine chemicals, will be making a tour of the Middle and Far East from 23 January to 15 March. Mr. Bailey will visit the agents of the two companies in the various countries, and he will also contact as many important industries and laboratories in each territory as possible. He proposes to visit Cairo, Karachi, Bombay, Ceylon, Calcutta, Singapore and Hong Kong.

After 40 years' service with the company and its predecessors, DR. A. G. WHITE, M.Sc., D.Sc., F.Inst.P., F.R.I.C., M.I.Chem.E., a managing director of the Nobel Division of Imperial Chemical Industries Ltd., has retired. In recent years Dr. White was entrusted with the task of guiding the I.C.I. project for the development of Ardil protein fibre at Dumfries. A Welshman, he is a graduate of the Aberystwyth College of the University of Wales. Dr. White joined the research department of Nobel's Explosives Co. Ltd. (a forerunner of the Nobel Division of I.C.I.) in 1914. He became joint research manager of the Nobel Division in 1942, when he also joined the Division board. He left research in 1945 to become Nobel Division director responsible for production with control also of the technical service and development departments. Three years later he was appointed senior director of the Ardil project and at that time also gave particular attention to the new mechanised blasting explosives project at Ardeer. He became a managing director of the Division in 1951 and from this time gave most of his attention to the development of Ardil. Dr. White's work on industrial explosives has led to important improvements in the process of manufacture of certain explosives, and he has

for many years given valuable service to the Government committee which deals with explosives in mines.

MR. W. R. STOREY, M.B.E., B.Sc., M.I.Mech.E., Assoc. M.I.C.E., who has been managing director of the Salt Division of Imperial Chemical Industries Ltd. since 1951, has retired. Mr. Storey studied engineering at Downing College, Cambridge, and joined Brunner, Mond & Company, one of the founder companies of I.C.I., in 1920. He became works manager of Wallerscote Works in 1928 and works manager of Winnington Works of Alkali Division in 1939. After transfer to the Salt Division as production director in 1948, he was appointed managing director of that division in 1951.

CAPTAIN W. E. SMITH, M.A., Barrister-at-Law, a director of the Metals Division of Imperial Chemicals Industries Ltd. and managing delegate director of Lightning Fasteners Ltd., has retired after more than 34 years' service with the company and its predecessors. A native of Leamington Spa, Captain Smith gained his degree at Cambridge, where he completed his Maths' Tripos with 1st class honours and was a Wrangler in 1914. He was called to the Bar in 1920 and in the same year joined the secretary's department of Kynoch Ltd. From that time he saw continuous service with the company and its successors until his retirement. After a number of years as personal assistant to the managing director he was appointed secretary in 1928 of the companies forming I.C.I. Metals Division, a position which he retained until 1947. He was appointed a Metal Divisions director in 1942 and managing director of Lightning Fasteners Ltd. in 1943.

A main board director of I.C.I., MR. A. T. S. ZEALLEY, J.P., M.Sc., A.R.I.C., is shortly to retire. Mr. Zealley went to Billingham in the early 'twenties to establish and develop the first ammonia plant. He became managing director and chairman of Billingham Division and was appointed to the main board in 1951.

MR. P. A. SINGLETON, managing director of Monsanto Chemicals Ltd., has announced the appointment of MR. N. F. PATTERSON, director and general manager of production, as operations director responsible for all manufacturing operations of the company.

MR. VEIKKO RAUHALA, who is a research assistant in the peat and oil laboratory of the State Institute for Technical Research, Helsinki, arrived in the United Kingdom from Finland on 10 January on a three months' British Council bursary to study the analysis of oil and oil products at Birmingham University, Department of Chemical Engineering. Mr. Rauhala who was a member of the State Central Committee for the Peat Industry has also worked with industrial firms in Sweden.

MR. A. E. J. GAWLER, deputy overseas controller of Imperial Chemical Industries Ltd., is leaving London by air on 29 January for Cairo. Mr. Gawler is a member of the Trade Mission sponsored by the Board of Trade which is to tour Egypt, the Sudan and Ethiopia. The mission plan to spend approximately two weeks in Egypt and a week each in the Sudan and Ethiopia.

DR. GEORGE W. RIGBY, of Wilmington, Delaware, USA, has been appointed European technical representative of E. I. Du Pont de Nemours & Company, American chemical manufacturers. Dr. Rigby will maintain his headquarters at the company's main offices in Wilmington, but will spend a substantial part of his time travelling in Europe, following technical and research developments there. He has been transferred from the company's development department to its foreign relations department for the new assignment.

MR. E. W. GANDERTON has joined the board of Stream-Line Filters Ltd. after several years as financial director of Powell Duffryn Ltd. He is also a director of Cie Français Powell Duffryn.

LORD CHANDOS, formerly Mr. Oliver Lyttelton, has been appointed to the board of I.C.I. as a non-executive director. Lord Chandos, who is 61, is chairman of Associated Electrical Industries and BTH.

Obituary

The death occurred on 11 January after a long illness of PROFESSOR ERNEST STEPHEN HAWKINS, O.B.E., Order of Al Rafidain, B.Sc., A.R.C.S., F.R.I.C., who for some years was Professor of Chemistry at Baghdad. A consultant chemist in partnership with his father in Canterbury, Professor Hawkins also held a public analyst's appointment. He became an Associate of the Royal Institute of Chemistry in 1927 and a Fellow in 1930.

Law & Company News

Commercial Intelligence

The following are taken from the printed reports, but we cannot be responsible for errors that may occur.

Mortgages & Charges

(Note.—The Companies Consolidation Act of 1908 provides that every Mortgage or Charge, as described herein, shall be registered within 21 days after its creation, otherwise it shall be void against the liquidator and any creditor. The Act also provides that every company shall, in making its Annual Summary, specify the total amount of debt due from the company in respect of all Mortgages or Charges. The following Mortgages or Charges have been so registered. In each case the total debt, as specified in the last available Annual Summary, is also given—marked with an *—followed by the date of the Summary but such total may have been reduced.)

AYRTON SAUNDERS & CO. LTD., Liverpool, manufacturing chemists.—13 December, mortgage (supplemental to a mortgage dated 10 January, 1923) further securing £19,000 outstanding and secured by said mortgage, to Refuge Assurance Co. Ltd.; charged on leasehold 32, 34 and 36 Hanover Street, Liverpool. *£19,250. 14 May, 1954.

HERON HEATING DEVICES LTD., Newcastle-on-Tyne.—17 December, £7,500 debenture, to Houseman & Thompson Ltd.; general charge (including patents, etc.).

LEDA CHEMICALS LTD., London W.—13 December, mortgage to City Prudential Building Society securing £2,200 and any other moneys, etc.; charged on 33 Balliol Avenue, Walthamstow. *£28,140. 22 December, 1953.

Increases of Capital

The following increases of capital have been announced: LAPORTE INDUSTRIES LTD., from £4,000,000 to £4,123,138; ENGLAND HUGHES BELL & CO. LTD., from £10,000 to £50,000; SUTELL WHOLESALE MANUFACTURING CO. LTD., from £2,000 to £8,000.

New Registrations

E. W. Edwardson & Co. (Ware) Ltd.
Private company. (542,357). Capital £100. Glue, gelatine, soap, polish and fertiliser compounders, manufacturers and merchants, bone crushers and merchants, etc. The subscribers (each with one share) are: Reginald A. Chiverrell and Miss Betty M. R. Mould. The first directors are not named.

Croxdale Engineering Development Co. Ltd.
Private company. (542,437). Capital £1,000. Manufacturers and repairers of and dealers in chemical plant, gas scrubbing plant, air conditioning equipment, etc. Directors: Eric E. McInnes and Stanley Todd. Secretary: E. E. McInnes. Reg. office: 1 St. Nicholas Buildings, Newcastle-on-Tyne 1.

Company News

British Industrial Plastics Ltd.
Group profits for the year ended 30 September of British Industrial Plastics Ltd. were £762,735, compared with £441,987 for the previous year. Net profit after taxation amounted to £265,878 (£104,120). A final dividend of 12½ per cent on capital increased by a 50 per cent scrip issue in July is recommended. This compares with last year's 12½ per cent payment on the smaller capital. The annual meeting will be on 31 March.

South African Druggists Limited
Trading profit of South African Druggists Ltd. showed an increase of £12,657, it was reported at the annual general meeting in Johannesburg on 30 December. However, decreased returns from subsidiaries and increased provision for taxation have resulted in the net profit being practically the same as at 30 June 1953. A dividend of 10 per cent on the ordinary shares, plus a bonus of 5 per cent, was approved.

Negretti & Zambra Ltd.
Negretti & Zambra Ltd. announce a final dividend of 10 per cent, making 13 per cent for the year ended 30 September, 1954, on a capital doubled by a scrip issue. Net profit before tax was £265,824, compared with £252,785 for the previous year.

Milton Antiseptic Ltd.
A dividend of 20 per cent (against 17½ per cent for the previous year) for the year ended 30 September, 1954, is recommended by the board of Milton Antiseptic Ltd. They also announce a free scrip issue of one ordinary for every share held. Group net profit before tax was £83,710 (£82,614) and taxed profit £36,200 (£22,967).

Non-Ferrous Metal Products Ltd.
The board of Non-Ferrous Metal Products Ltd. has recommended a dividend of 6 per cent for 1954. This compares with 5 per cent paid since the company was first made public in 1952. Net revenue rose from £20,458 to £28,083.

Next Week's Events

MONDAY 24 JANUARY

Chemical Society

Cardiff: Chemistry Department, University College, 5.30 p.m. 'Some Recent Advances in Photochemistry' by Professor R. G. W. Norrish.

Society of Chemical Industry

Leeds: 'Chemistry Department, The University, 7 p.m. 'Flexible Materials in Packaging' by G. H. Edwards (joint meeting of Food Group and Yorkshire Section).

Institution of the Rubber Industry

Manchester: Engineers' Club, Albert Square, 6.15 p.m. 'Use of Rubber in Pressure Sensitive Adhesive Tapes' by J. Dow.

Incorporated Plant Engineers

Liverpool: Radiant House, Bold Street, 7.15 p.m. 'Planned Maintenance as a Contribution to Higher Productivity' by A. J. Speakman.

TUESDAY 25 JANUARY

Chemical Society

Belfast: Agricultural Lecture Theatre, Queen's University, 7.15 p.m. 'Modern Insecticides and their Uses' by A. L. Abel (joint meeting with SCI).

Textile Institute

Manchester: 10 Blackfriars Street, 7 p.m. 'Moisture Relations and Drying of Textiles' by Dr. J. M. Preston.

Society of Instrument Technology Ltd.

London: Manson House, Portland Place, W.1, 6.30 p.m. 'Instruments for Research on Mining Problems' by Professor E. L. J. Potts.

WEDNESDAY 26 JANUARY

Society of Chemical Industry

London: Chemical Society's Rooms, Burlington House W.1, 6.30 p.m. Food Group (Nutrition Panel) meeting. 'Soya in the Field of Nutrition' by E. Mitchell Learmonth.

Manchester Metallurgical Society

Manchester: Lecture Room, Central Library, 6.30 p.m. 'Cathodic Protection' by Dr. W. F. Higgins.

THURSDAY 27 JANUARY

Chemical Society

Bristol: Chemistry Department, The University, 7 p.m. 'Recent Advances in the Bacteriological Examination of Water' by Dr. E. Windle Taylor (joint meeting with RIC, SCI and Society for Analytical Chemistry).

Hull: The University, 6 p.m. 'Some Modern Ideas on the Nature of the Covalent Bond' by Professor C. A. Coulson.

Liverpool: Chemistry Lecture Theatre, The University, 5 p.m. 'Structure and Properties of Synthetic Polypeptides' by Dr. C. H. Bamford (joint meeting with University Chemical Society, RIC, SCI and BAC).

Nottingham: The University, 4.45 p.m. 'Phenylation' by Professor D. H. Hey (joint meeting with University Chemical Society).

Sheffield: Chemistry Lecture Theatre, The University, 7.30 p.m. 'Some Naturally Occurring Polyacetylenes' by Professor B. Lythgoe (joint meeting with University Chemical Society).

Bangor: Department of Chemistry, University College of North Wales, 5.45 p.m. 'Factors Involved in the Formation of Carbonium Ions' by Professor A. G. Evans (joint meeting with University of North Wales Chemical Society).

Fertiliser Society

London: Lecture Hall, Royal Sanitary Institute, 90 Buckingham Palace Road S.W.1, 2.30 p.m. 'Nitrogenous Fertiliser Production' by W. K. Hall, O.B.E.

Institute of Fuel

London: Institution of Civil Engineers, Great George Street S.W.1, 5.30 p.m. Paper of the Dutch State Mines (joint meeting with Coke Oven Managers' Association).

Liverpool: Liverpool Engineering Society's Rooms, 9 The Temple, Dale Street, 7 p.m. 'Atomic Energy' by J. C. C. Stewart.

Incorporated Plant Engineers

Sheffield: Grand Hotel, 7.30 p.m. 'Factory Flooring Problems' by A. E. Rice.

FRIDAY 28 JANUARY

Chemical Society

Cambridge: University Chemical Laboratory, Pembroke Street, 8.30 p.m. 'Topology and Chemistry' by Dr. A. F. Wells (joint meeting with University Chemical Society).

St. Andrews: Chemistry Department, The University, 5.15 p.m. 'Recent Advances in Acetylene Chemistry' by Professor R. A. Raphael (joint meeting with University Chemical Society and RIC).

Society for Analytical Chemistry

London: School of Pharmacy, Bloomsbury Square, W.C.1, 7.30 p.m. 'Micro-

chemical Problems in Pharmacy,' meeting organised by the Microchemistry Group and preceded by the group's annual general meeting.

Institute of Metal Finishing

Sheffield: Grand Hotel, 6.30 p.m. 'Bright Nickel' by A. F. Brockington and 'Barrel Polishing in General' by A. Bryan.

Incorporated Plant Engineers

Birmingham: Imperial Hotel, 7.30 p.m. 'Auto Controls for Plant' by M. C. Rogers.

Society of Instrument Technology Ltd.

Glasgow: Natural Philosophy Department, Royal Technical College, 7 p.m. 'Industrial Pressure Measurement' by C. F. Budenberg.

SATURDAY 29 JANUARY

Institution of Chemical Engineers

Birmingham: The University, Edmund Street, 2.30 p.m. Annual general meeting of Midlands branch, followed by 'The Application of the Continuous Solid Bowl Centrifuge to the Chemical and Allied Industries' by G. D. Kelsey.

Manchester: Engineers' Club, 2.30 p.m. Annual general meeting of North Western branch, followed by 'Some Aspects of the Chemical Processes Ancillary to Atomic Energy' by Sir Christopher Hinton.

Society for Analytical Chemistry

Manchester: Engineers' Club, 2 p.m. Annual general meeting of North of England section followed by an ordinary meeting on 'The Importance of Analysis in Industry' by Dr. J. Haslam.

Society of Leather Trades' Chemists

Manchester: Reynolds Hall, Manchester College of Technology, 2 p.m. 'Vegetable Tanning' by Professor D. Burton and 'The Fastness of Dyestuffs on Leather' by F. Russell and T. C. Mullen.

Sulphur Syndicate Change

FUNCTIONS of the executive office of the Sulphur Exploration Syndicate will be assumed by the British Sulphur Corporation Ltd., as from 1 February. The change is being made partly for administrative reasons, and partly to provide the necessary financial backing for the continuance of activities. Offices will be at 4 Grafton Street, London W.1. The objects of the Corporation are similar to those of the Syndicate, and the Quarterly Bulletin will continue to be published.

In order to keep abreast of new developments, the Corporation will maintain its interest in new sulphur-producing projects and processes which, when desirable, will be publicised in the Bulletin. In appropriate cases, the Corporation may, either directly or indirectly, consider financial participation in a sulphur producing project or extending assistance in the disposal of sulphur so arising. It is the Corporation's intention to continue the building-up of the unique and comprehensive record of the sulphur industry begun by the Syndicate, and to increase its scope and value.

Market Reports

LONDON.—Conditions on the industrial chemicals market show little change over the past week, and most sections report a steady movement with good quantities going forward against contracts. Prices are well held and the undertone is firm. The lead compounds, however, are lower as from 15 January. Dry white lead is now £137 10s. per ton, the basis price for red lead £132 5s. per ton and litharge £134 5s. per ton. In the coal tar products market pitch continues to be active on home and export account, and there is a steady call for the pyridines and creosote oil.

MANCHESTER.—Steady to firm price conditions in almost all sections of the Manchester market for heavy chemical products has been indicated during the past week. Contract deliveries for the alkalis and other bread-and-butter lines are being taken up in satisfactory quantities and a fair number of fresh inquiries from home users as well as on export account have been in the market. The market for fertiliser materials is slow to display much improvement, adverse weather conditions apparently being against freer operations. A steady demand for most of the light and heavy by-products continues to be reported.

Fatty Acids

An advertisement which appeared in our 8 January issue, p. 76, for Victor Wolf Ltd., manufacturers of fatty acids, was wrongly worded in two particulars. A corrected version appears in this issue on p. 298.

CLASSIFIED ADVERTISEMENTS

SITUATIONS VACANT

The engagement of persons answering these advertisements must be made through a Local Office of the Ministry of Labour or a Scheduled Employment Agency if the applicant is a man aged 18-64 inclusive, or a woman aged 18-59 inclusive, unless he or she, or the employment, is excepted from the provisions of the Notifications of Vacancies Order, 1952.

A. BOAKE, ROBERTS & CO. LTD., LONDON, E.15, require **SENIOR CHEMISTS** for their Process Development Dept. These appointments would appeal to qualified men with some years experience of organic chemistry, seeking the opportunity to lead a team in developing new projects from laboratory to plant scale so as to provide new or improved products. The minimum salary envisaged is £800 per annum. Write giving full details of qualifications and experience, to **THE PERSONNEL MANAGER.**

ARMSTRONG SIDDELEY MOTORS needs a **CHEMIST** as assistant to the Chief Chemist in their Rocket Division for research in an unusual field, with a wide range of materials. Degree or A.R.I.C. essential. Good prospects. Apply giving details of experience to Reference **CG/RL1, TECHNICAL PERSONNEL MANAGER, ARMSTRONG SIDDELEY MOTORS, COVENTRY.**

CHEMISTS required for Synthetic Phenol Plant near Pontefract. Experience in industrial organic or inorganic fields an advantage. Minimum qualifications required: O.N.C. Contributory pension arrangements available. Apply, giving particulars of age, qualifications, experience and salary required, to **SECRETARY, SYNTHETIC CHEMICALS, LTD., COMMON LANE, KNOTTINGLEY, YORKSHIRE.**

INDUSTRIAL CHEMIST required by leading Container Closure Manufacturers in Midlands. Progressive position requiring knowledge metal printing, varnishing, stoving and metallurgy, associated with food packaging industry. Maximum age, 35 years. Written applications with details of experience, previous appointments, etc., to **A.G.M. METAL CLOSURES, LTD., BROMFORD LANE, WEST BROMWICH, STAFFS.**

PHYSICAL CHEMIST (or Physicist, with knowledge of Analytical methods) to take charge of Works Control Laboratory in Hertfordshire: Graduate preferred. Initial salary approximately £1,000 per annum (according to qualifications for post). Excellent prospects. Pension and Profits Participation Schemes. Write full details, age, qualifications, experience to date, to **REF. P.C., BOX No. 8282, c/o CHARLES BARKER & SONS, LTD., 31, BUDGE ROW, LONDON, E.C.4.**

FOR SALE

CHARCOAL, ANIMAL AND VEGETABLE horticultural, burning, filtering, disinfecting, medicinal, insulating; also lumps ground and granulated; established 1830; contractors to H.M. Government.—**THOS. HILL-JONES, LTD., "INVICTA" WORKS, BOW COMMON LANE, LONDON, E. TELEGRAMS: "HILL-JONES, BOCHURCH LONDON." TELEPHONE: 3285 EAST.**

FOR SALE

ECONOMIC BOILERS, Two Brand New 14 ft. by 8 ft. by 150 lb. w.p. **IMMEDIATE DELIVERY** 400 other Boilers in stock.

STAINLESS PRESSURE TANK, 19 ft. by 5 ft. diam., 110 lb. w.p. Unused.

STAINLESS PANS: four 60 gall. double jacketted; 120 gallon jacketted with agitator.

TWO 35 ft. long by 9 ft. diam. Lead-lined **TANKS.**

TWO Broadbent **WATER-DRIVEN CENTRIFUGES,** 30 in. diam., 12 in. deep, 1,150 r.p.m.

SIX Aluminium **CONDENSERS,** 14 ft. long by 2 ft. 6 in. diam. 386 Tubes, ¾ in. o.d.

FORTY Riveted **RECEIVERS,** 8 ft. 6 in. long, 5 ft. 6 in. diam., 75 lb. w.p. Numerous other sizes.

Solid Drawn **STEEL PIPES,** 6 in., 8 in., 10 in., 12 in., 14 in., thousands of feet in stock, plain and flanged.

CAST-IRON PIPES. 400 yds. 8 in. **NEW.** Also most other sizes, up to 24 in. bore.

VALVES in Stainless, Gunmetal, Enamel Lined.

CAST IRON TANK PLATES, 2 ft. square. 500 in stock. Free Catalogue. "Watkins Machinery Record," available.

FRED WATKINS (BOILERS), LTD., COLEFORD, GLOS.

FIVE BRAND NEW STERILISING VESSELS—7 ft. long by 3 ft. diameter.

One 4 ft. Positive-driven **EDGE RUNNER MILL**—with reduction gear, motor and starter.

One **S. J. WERNER MIXER** with pan approx. 2 ft. by 2 ft. of the tilting type.

Two steam jacketed **CAST-IRON FILTER PRESSES**—each with 38 s.j. plates and 39 frames, cake size 2 ft. 4 in. square.

Several **JOHNSON CAST-IRON FILTER PRESSES**—various sizes and types.

GARDNER MIXERS and Mixers and Sifters combined, sizes "E," "G," "H" and experimental.

HYDRO EXTRACTORS—24 in., 30 in. and 36 in.

Two Gardner "H" size Steam-jacketed **MIXERS.**

Two 18 in. **KEK PLATE MILLS**—with feeders delivery bins, motors and entablature.

RICHARD SIZER, LTD., ENGINEERS, HULL.

Telephone: 31743.

PHONE 98 STAINES

DEHNE Wood Plate **FILTER PRESS**—31 plates, 30 in. square.

De Laval No. 2 **EMULSIFIER**—400/3/50.

STAINLESS STEEL ELEVATOR—40 ft. long.

1,500, 1,200 and 1,000 gal. **ALUMINIUM TANKS.**

Twin-spiked **ROLL CRUSHER**—18 in. by 12 in.

(30) **"Z"** and **FIN-BLADE JACKETED AND PLAIN MIXERS**—up to 42 in. by 28 in. by 38 in. deep.

UNUSED ELECTRIC STIRRERS—400/3/50, ¼ h.p.

JACKETED PANS, PUMPS, HYDROS, CONDENSERS, STILLS, GRINDERS, BALL MILLS, EDGE RUNNERS, etc.

HARRY H. GARDAM & CO., LTD., STAINES.

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